OLUME 51 NUMBER 1 . . . ONE YEAR THREE FIFTY

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GENERAL ELECTRIC Review

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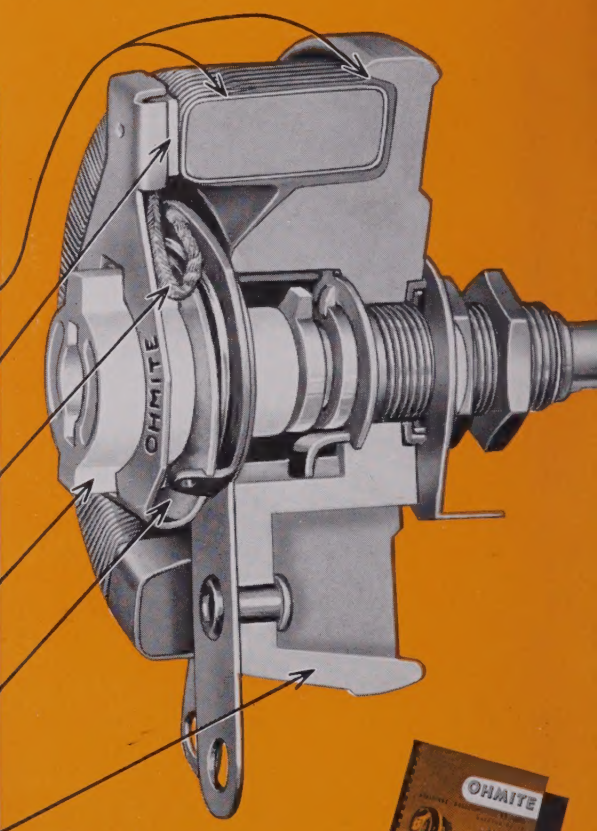
ELECTRICAL AND ALLIED DEVELOPMENTS OF 1947

January, 1948

Here's why you get YEARS OF UNFAILING OPERATION with OHMITE Rheostats

Ohmite rheostats are engineered to give long, trouble-free service and unmatched smoothness of action. Following are a few of the features that make possible their outstanding performance:

- **VITREOUS ENAMEL BOND**—Core and base are bonded together by vitreous enamel into one integral unit. Each turn of wire is also permanently locked in place by vitreous enamel.
- **METAL GRAPHITE BRUSH**—Perfect contact with negligible wear on the wire is insured by the metal-graphite contact brush (varied to fit the current and resistance) and the large, flat contact surface.
- **LARGE PIGTAIL SHUNT**—Current is carried directly to the slip-ring by a pigtail shunt of ample size, assuring an uninterrupted connection at all times. Large slip-ring minimizes mechanical wear.
- **INSULATED SHAFT AND BUSHING**—High strength ceramic hub insulates the shaft and bushing from all live parts. Underwriters' Laboratories listed models are available.
- **UNIFORM CONTACT PRESSURE**—Tempered steel contact arm forms a long steel spring which assures uniform contact pressure. Universal joint action of the brush maintains "flush-floating" contact.
- **ALL CERAMIC AND METAL CONSTRUCTION**—Ohmite rheostats have a ceramic core, base, and driving hub. There is only ceramic and metal in their construction—nothing to char, burn, shrink, or deteriorate. They are designed for long, trouble-free life.



Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING COMPANY
4810 Flournoy Street, Chicago 44, Illinois

GENERAL ELECTRIC REVIEW

JANUARY, 1948
Vol. 51, No. 1

THE COVER

ie Boulevard in Schenectady, once a section of historic Erie canal, recently re-equipped with ern street lighting is now one of the country's lighted thoroughfares. This boulevard is the approach to the Schenectady Works of the eral Electric Company, whose progress during in the development and output of electrical pment is recounted in this issue.

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ELECTRONICS

Designers

Television Transformers...tailored to your needs

1. Line supply voltage and frequency
2. High voltage d-c required
3. D-c milliamperes required
4. Filament volts and amperes
5. Sub-panel or above-panel mounting
6. Description of rectifier circuit
7. Winding insulation voltage required
8. Maximum ambient temperature

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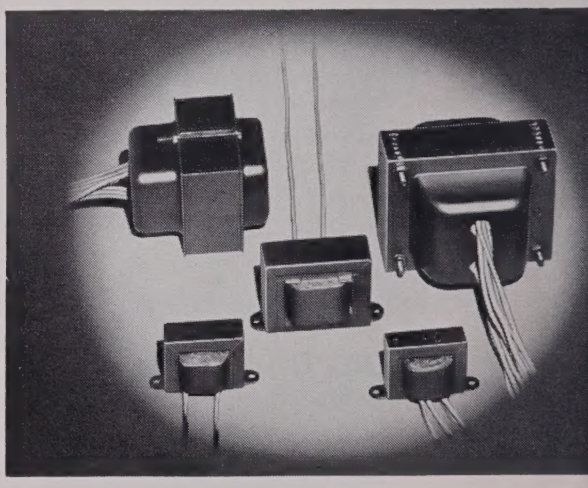


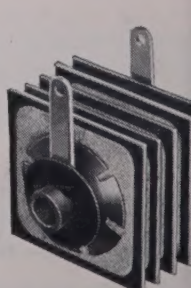
Whatever your transformer needs—power units like these, or special designs for deflection yokes, horizontal or vertical sweeps, or oscillators—General Electric can supply them . . . and quickly. G.E. offers its facilities and engineering "know-how" to television manufacturers in tailoring these transformers to their requirements. Just tell us your specifications and we will meet them to your complete satisfaction. Power-supply transformers are available now in core-and-coil and enclosed-case styles as standard units designed for television applications. Units for other uses are tailor-made from standard parts. Ask your G-E representative for more information; you'll be pleased with the prices and shipments he will offer you.

NEW PYRANOL CAPACITORS SAVE SPACE, WEIGHT, MONEY

If you have been using 600-volt d-c capacitors on circuits rated 400 volts or less, you're in for a substantial saving in weight, size and cost by specifying General Electric's new 400-volt Pyranol units. Compared with 600-volt ratings, these new, standard, 400-volt capacitors will save you from 24 to 51 per cent in volume, 23 to 33 per cent in weight, and approximately 10 per cent in cost. They are available in 2-, 4-, 6-, 8- and 10-muf ratings with solder-lug or screw-thread terminals optional on the four larger sizes; the 2-muf size comes with solder-lug terminals only.

New developments, such as silicones and new paper, are continually improving the quality of G-E capacitors. They also permit our engineers to handle your new requirements to your complete satisfaction. Write for quotation on any capacitor needs, or check Bulletin GEA-2621 for more information on the new d-c line described above.

NEW, SMALLER SELENIUM RECTIFIER



This new General Electric selenium rectifier, less than one inch long and one inch square, is available now for receiver and other elec-

GENERAL ELECTRIC

ELECTRICAL AND ALLIED DEVELOPMENTS DURING 1947

By GUY BARTLETT
General Electric Company, Schenectady, N. Y.

PROGRESS was conspicuous in the electrical manufacturing industry in 1947. There were intense and effective research and engineering studies. In many industries there were trends toward greater use of electricity—use of power reached an all-time high. New records were set for speed, power, and size of equipment. There was a wide variety of new or improved products for industry, commerce, and home. Research, engineering, and manufacturing facilities were still being expanded.

Studies and Investigations

High-lighting the research and engineering studies were, among others: extensive investigations in the field of atomic energy for power production; and the production and use of betatrons, synchrotrons, and other atom-smashing machines for probing into the secrets of the atom. Rocket propulsion motors, their contouring, fuels, and controls received much attention. The gas turbine—famed in jet-propelled airplanes—was undergoing exhaustive tests.

Looking forward to the day when higher voltages will be required for transmission lines, equipments were being designed, produced, and tested for use at 360,000 volts or more. Research and fundamental development in aviation went ahead at a rate comparable with that maintained during the war years.

The year had its full share of firsts and largests. Among these, there were electric locomotives that set records for both size and power. Also, two of the largest placer dredges ever built were delivered for tin-mining operations. Eight turbo-jet engines powered the newest giant Flying Wing. There were many particularly large electric motors for industrial drives. Steam turbines were record-breaking not only because of the number which will operate with steam at over 1000 F temperature, but also because of their size.

There were numerous industrial trends of importance. The steel industry, for instance, continued to emphasize the need for more automatic equipment, higher speeds, and a greater output per mill or processing unit to combat rising costs. In rubber mills there was a definite trend to the use of completely electrified drives, using individual motors. Induction and dielectric heating found new, advantageous applications; and so did electronic control equipments.

Improved Products

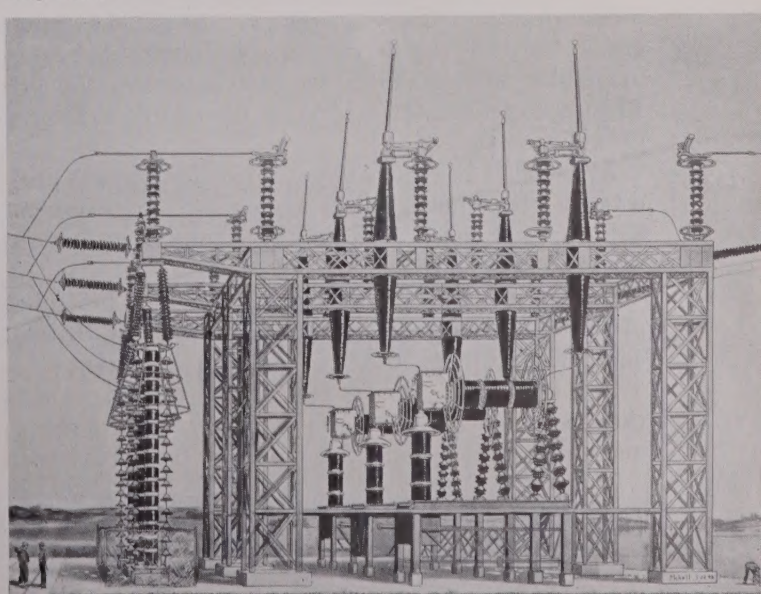
Announcements of new or greatly improved products were both numerous and important. A small, more efficient refrigerating unit appeared for both air-conditioning and home-appliance applications. A half-dozen new types of jet-propelled airplanes flew for the first time. Ever-increasing power demands of both military and commercial airplanes were met with new equipment. Larger subway cars for New York City will operate more smoothly and quietly. New alloys, plastics compounds, and resins emerged from the laboratories.

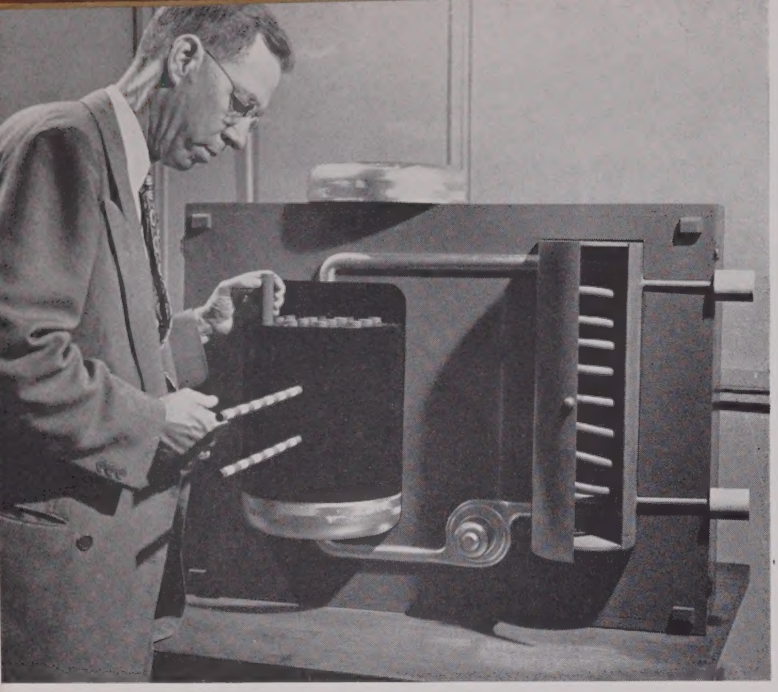
Research Expanded

Research facilities were being expanded. Pittsfield will have the world's largest man-made lightning center. At Schenectady, construction was going ahead on the Knolls Atomic Power Laboratory of the Atomic Energy Commission and on the new G.E. Research Laboratory. Manufacturing facilities were similarly being expanded. For alkyd resins there was a new plant at Anaheim (Calif.); for laminated plastics, one at Coshocton (Ohio); for molded plastics, at Decatur (Ill.); and for silicones, at Waterford (N. Y.). Largest plant under construction was the one at Schenectady for steam turbines and electric generators, covering approximately 19 acres. These were not all, but they are representative of the extent of expansion.

Although the electrical, mechanical, and chemical developments of only the General Electric and its affiliated companies are included, the material in the following pages is indicative of the trends in design and construction in the electrical manufacturing industry as a whole.

A substation for 360,000-volt power transmission, for the super-high-voltage test line being built at Brilliant (Ohio) by The American Gas and Electric Corporation





An atomic power plant—not full scale, and quite schematic. At the left is the atomic "pile" where matter is transformed into energy by the splitting of uranium or other fissionable material. In his left hand the demonstrator holds a rod of this "fuel" material. The horizontally projecting striped rods represent the control rods which prevent the process from running away. A heat-exchanging fluid would be pumped through the pile, thence to the heat exchanger at the right, where water would be turned to steam. This steam would then be used to drive turbines in the customary way. The heat exchanger keeps the steam from becoming radioactive. The pile and heat exchanger are sealed in concrete or similar protective material, as indicated by the enclosing block in the model

RESEARCH

AND LABORATORY INVESTIGATIONS

• • • • • • • • •

Atomic Power . . . *Toward the Day*

RADIO Isotopes Available for Research Here and Abroad—Plutonium Pile, Relatively Small, Needs No Moderator—Atomic Power for Ships and Robot Planes Studied—these were among the headline topics of 1947 in the field of nucleonics.

Using pure plutonium, a man-made element that was unknown only a few years ago, it is possible to operate a relatively small reactor, or "pile," without a moderator to slow down the fast neutrons, the Los Alamos experimental station of the Atomic Energy Commission stated.

Availability of radioactive-isotopes for research projects of other nations was announced by President Truman; and beneficial results of isotope investigations began to be reported.

Atomic energy for ship propulsion and for robot planes was being studied. Canada and Great Britain, and perhaps others, also had "piles" in operation.

Beyond these—and a few more—announcements there were not many reports on the year's progress in nucleonics, in the production of energy from matter. In this respect things were as expected, for there remains much fundamental work to be done before attention can be given to the actual construction details of atomic power plants.

Studies were being made, or planned, in many fields. The type of fuel, the problems of "stability," the best material for use as the "moderator," the selection of the heat-transfer medium, how to insert the fuel and remove the "ash," safety for operators, and reliability and long-life of all elements—these were among the many problems to be solved. Neutron absorption, stability under x-ray bombardment, strength at high mechanical stress and high temperature, corrosion erosion—these, and many more, were factors to consider.

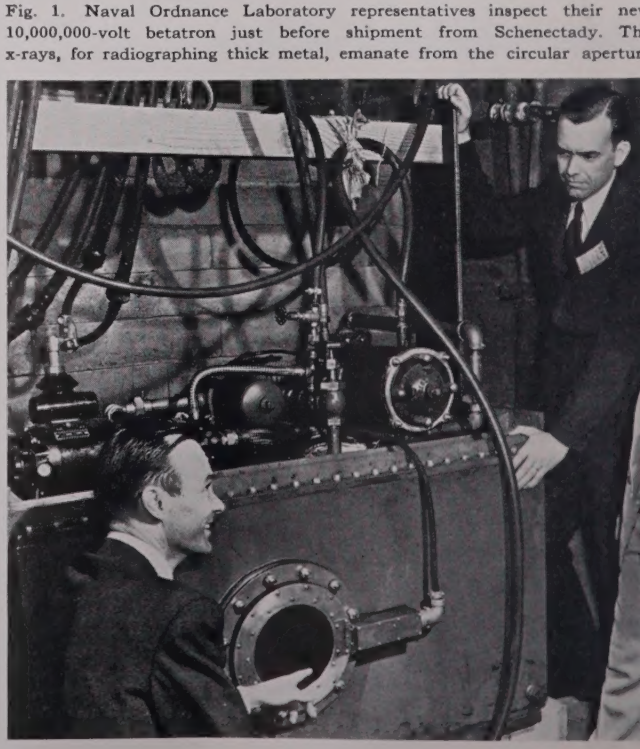
At the Hanford Works of the U.S. Atomic Energy Commission, near Richland (Wash.), General Electric was the operating agency in plutonium production and in physical and chemical research. Just outside Schenectady, the Knolls Atomic Power Laboratory, also with General Electric as the operating agency, was under construction for applied research and engineering development for industrial atomic power. At Schenectady there is also a new Research Laboratory under way, to house nuclear researches supplementing these other studies.

Although it will be a matter of years before a small scale pilot power plant is in operation, and many more years before the first full-scale plant will be completed it was possible to get an idea how atomic power plants might look.

Particle Accelerators . . . *Fast X-rayin*

A 10,000,000-volt betatron which can take an x-ray picture of a piece of steel 10 in. thick in a few minutes was built in the General Engineering and Consulting

Fig. 1. Naval Ordnance Laboratory representatives inspect their new 10,000,000-volt betatron just before shipment from Schenectady. The x-rays, for radiographing thick metal, emanate from the circular aperture



aboratory for the Naval Ordnance Laboratory, White Oaks (Md.). First of its size for industrial use, it will be mployed in radiography of castings and weldments of aval guns, directors, armor plate, and other ordnance quipment. The machine (**Fig. 1**) is a small version of he Company's 100,000,000-volt atom-smashing betaron; and it is considered the ideal size for industrial adiography of thick specimens. Betatrons with higher nergies, although invaluable in nuclear research, have eams too narrow for use at close range in many cases.

Construction was nearing completion at the end of he year on a 50,000,000-volt betatron for the U.S. Bureau of Standards, announced last year. Components ere being built for a still larger machine, a 70,000,000-olt synchrotron for Iowa State University. It will duplicate in size and energy the unit at the Research aboratory in Schenectady, the only synchrotron now n operation in this country. Combining techniques mployed by the earlier betatron and cyclotron, the ynchrotron accelerates electrons in a doughnut-shaped acuum tube, first by magnetic field and then by an lectric field.

Still under construction were two 100,000,000-volt etatrons for the University of Chicago and the Clinton aboratories at Oak Ridge (Tenn.). Also for nuclear esearch was a 3,500,000-volt electrostatic proton accelrator on which work was commenced during the year.

Water Table . . . *Fluid Flow*

Based upon the close analogy that exists between wo-dimensional air flow and the behavior of surface aves in water when the depth is small compared to the avelength, a water table was developed for both qualiative and quantitative studies of fluid flow. A horizonal surface of plate glass is provided with means for

new electron diffraction instrument is shown here in the Research aboratory where it is being used in the study of rust, corrosion, lubrication, nd other problems having to do with surfaces

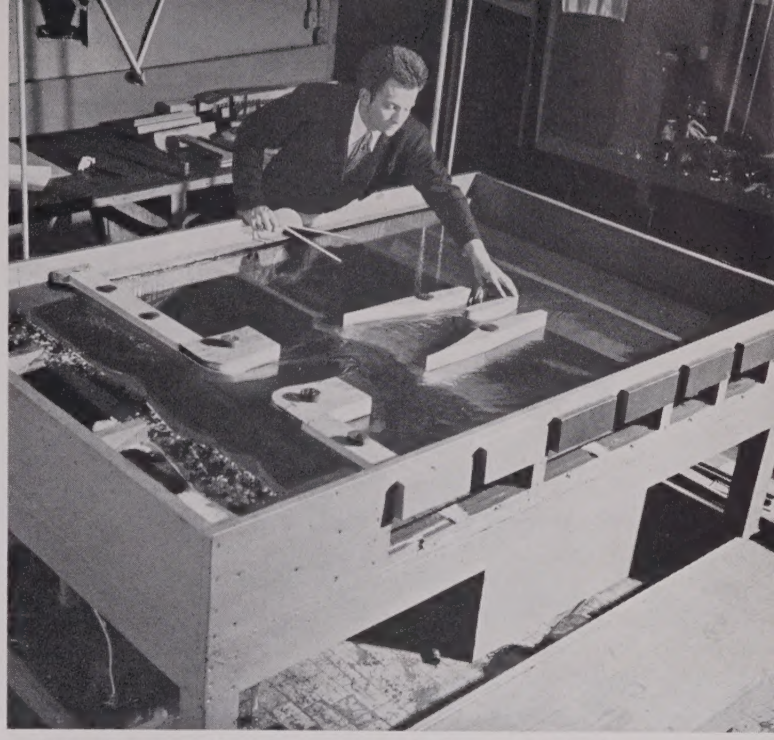


Fig. 2. The water table—a device for the study of supersonic velocities

altering the inclination. A pumping system circulates the water, and acceleration is produced by means of a dam with sloping spillway (**Fig. 2**). Depths are measured by means of a depth gage and by coating model sections with a water-soluble dye.

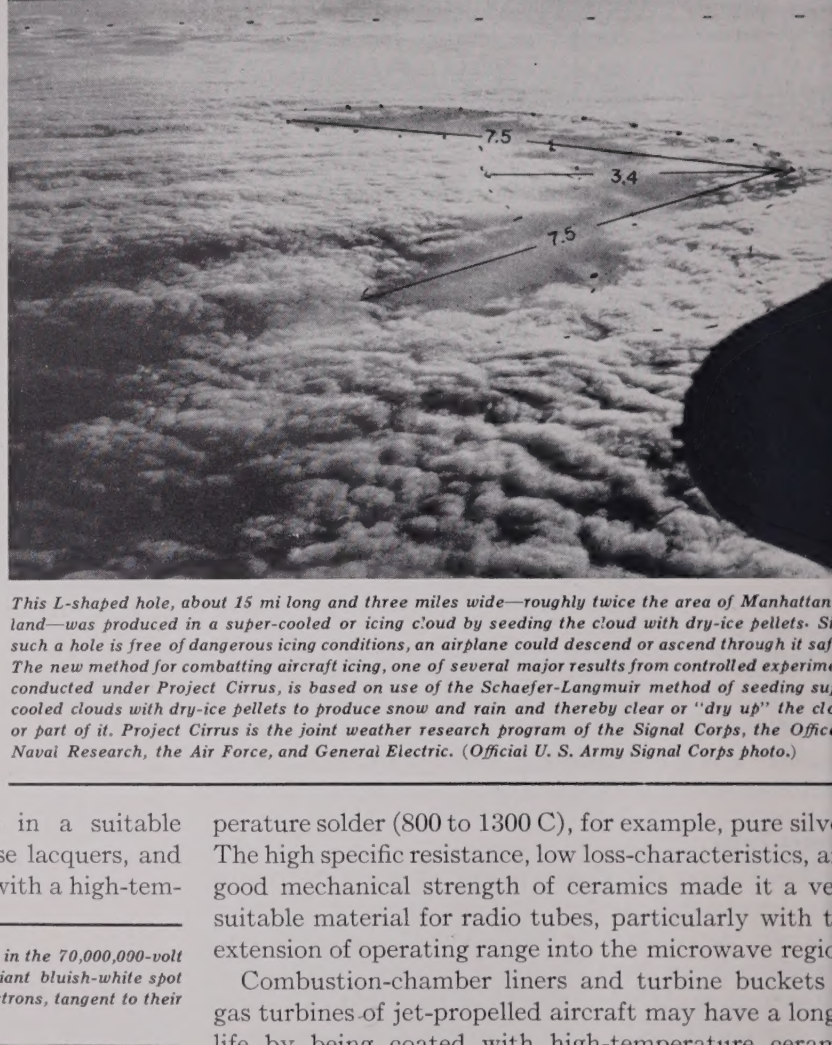
In studying the flow of gases over specially designed surfaces, such as in ram jets, rockets, etc., it is helpful to construct a small model, place it on a table, and observe the stream line of the water flow around it. Quantitative measurements of depths give information regarding pressure and temperatures in full-scale air flow. The water table is used for visible flow demonstrations, for quantitative investigations of lift, drag and moment of air foils, and for studies in supersonic diffuser design. An advantage of the model is that it affords means of making experimental observations with high Mach numbers—at velocities considerably above that of sound.

Germanium . . . *Rectifier*

Germanium is one of a small group of solids known as semiconductors, possessing electrical properties intermediate between those of metals and insulators. A crystal rectifier of the point-to-plane type, making use of the unusual conducting properties of germanium, was developed; as radio communication was extended to ultrahigh frequencies, this assumed new importance. The germanium unit was designed originally as a high-sensitivity, low-loss detector at microwave frequencies, but it was observed that the addition of suitable donors resulted in unusually high burn-out characteristics. This led to adapting the microwave unit to high-voltage rectification. As a rectifier in a single-phase half-wave circuit, these units have operated without failure for as many as 5000 hours while delivering 0.05 amp d-c and supporting a peak inverse voltage of 80 volts. They can be adapted to such uses as voltage regulators and low-frequency oscillators as well as detectors and rectifiers.

There are no problems of insulation, a-c hum, or noise, since the germanium functions as a unipotential cold cathode, eliminating the heater supply of hot-cathode diodes. The small weight and size makes the germanium diode suitable for use in portable electric equipment.

Two new compounds of germanium —dimethyl germanium sulfide and dimethyl germanium oxide—were announced from the Research Laboratory. The latter is quite soluble and may have medical applications; about 15 years ago it was found that compounds of germanium could stimulate production of red blood cells in mammals, and experiments were made with them in the treatment of anemic conditions.



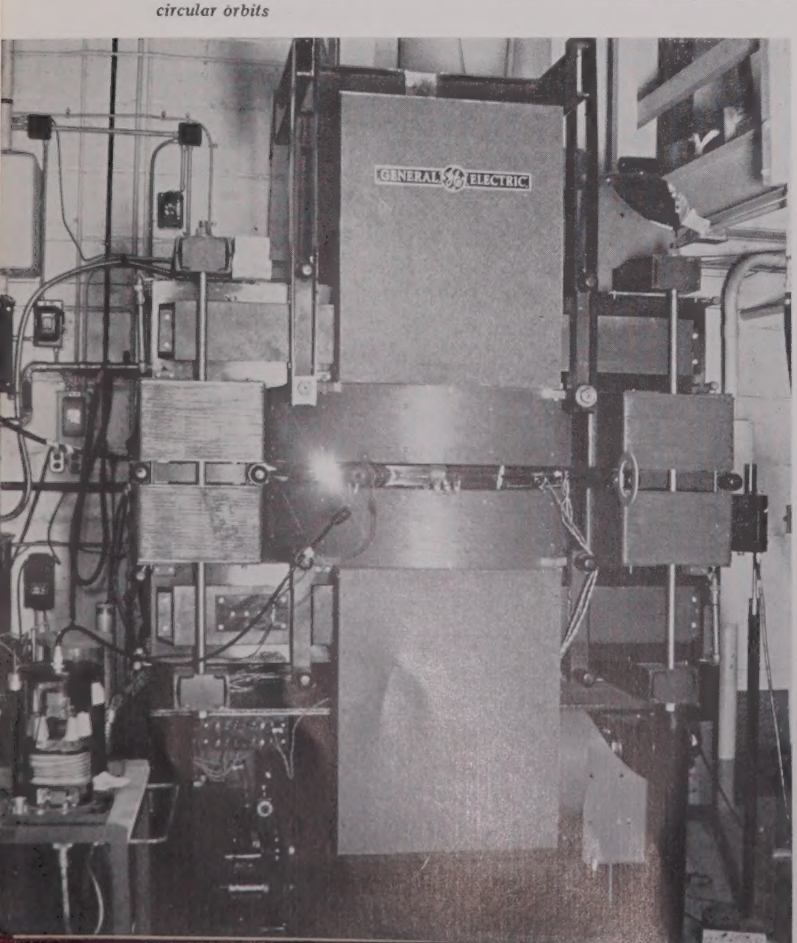
This L-shaped hole, about 15 mi long and three miles wide—roughly twice the area of Manhattan land—was produced in a super-cooled or icing cloud by seeding the cloud with dry-ice pellets. Si such a hole is free of dangerous icing conditions, an airplane could descend or ascend through it saf The new method for combatting aircraft icing, one of several major results from controlled experim conducted under Project Cirrus, is based on use of the Schaefer-Langmuir method of seeding su cooled clouds with dry-ice pellets to produce snow and rain and thereby clear or "dry up" the cl or part of it. Project Cirrus is the joint weather research program of the Signal Corps, the Offic Naval Research, the Air Force, and General Electric. (Official U. S. Army Signal Corps photo.)

Ceramics . . . *Strong Bonds*

A permanent hermetic bond between ceramic materials and metals was previously announced. It was disclosed that the process consists of coating the surface of the ceramic with a paint composed of titanium hydride in a suitable carrier, such as one of the nitrocellulose lacquers, and then soldering the ceramic to the metal with a high-temperature solder (800 to 1300 C), for example, pure silv The high specific resistance, low loss-characteristics, a good mechanical strength of ceramics made it a ve suitable material for radio tubes, particularly with t extension of operating range into the microwave regi

Combustion-chamber liners and turbine buckets gas turbines of jet-propelled aircraft may have a long life by being coated with high-temperature ceran glazes. Such an application of ceramics is still a search development, however, and has not been used gas-turbine production. Investigations of solid ceran turbine buckets were also being made, it was announc

An electron beam has been made visible by its own light in the 70,000,000-volt synchrotron. Inside the doughnut-shaped tube, a brilliant bluish-white spot appears. It is from light beamed forward from the electrons, tangent to their circular orbits



Shielded Arc Welder . . . *Precision Weld*

Of great value in the manufacture of magnetro and other devices requiring precision welding was argon-shielded arc-welding apparatus. Owing to t localization of the heating, stock as thin as 10 mils h been successfully welded, and welds can be made safe very near to glass parts.

A constant speed is maintained by a Thy-mo-t unit having a dial speed control. The object to welded is chucked in the lathe and serves as one of t electrodes. The other electrode is surrounded by a tub lar jacket through which a stream of argon is pass from a pressure tank—argon maintains a constant a voltage independent of arc length. The current is c ried by the gas stream instead of by the arc itself as the ordinary metal arc, and the energy required relatively low. Instead of transferring metal from t electrode to the work, the shielded arc applies sufficie heat locally to fuse the metals that are in contact. T method is free from bubbles of trapped gas.

pectro-radiometer . . . *For Low Brightness*

A spectro-radiometer was developed for automatically recording the spectral energy distribution of ontinuous sources of low brightness, such as fluoresent lamps and cathode-ray tubes. It was applied in the udy of spectral distribution of fluorescence from zinc eryllium silicate as a function of composition and heat reatment, in establishing basic standards for the color f television tubes, and in various lamp problems.

yotron . . . *And Other Tubes*

In the Research Laboratory there were several electronic developments, including the dyotron—a new icrowave oscillator developed from the conventional iode structure by the employment of a new principle f operation. The method provides an oscillator which tilizes only one tuned circuit instead of the usual two r more. The circuit can be tuned over a frequency ange of about 3:1 with a single control. Since the frequency stability is high and deviations are usually not nore than 0.005 per cent, the dyotron promises to be a seful tool in several microwave applications.

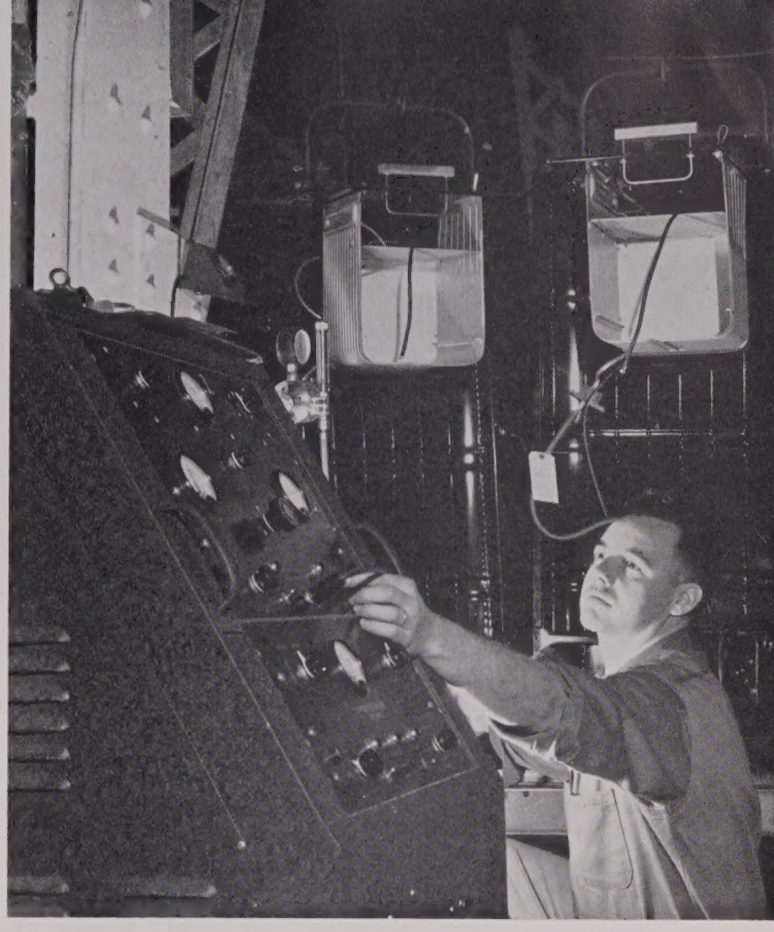
By use of a new combination of powdered-iron core aterial and a binder, it became possible to design and uild radio-frequency transformers having very small imensions. One is so small it can be "turned on a dime." his work was done under a development contract with he U. S. Army Signal Corps Engineering Laboratories.

Change in calibration with line voltage, a troubleome feature with electronic interval timers, has been vercome in a simple new circuit combination, adjustble to time intervals from 2 to 120 sec.

Based on the principle of the war-developed proxnity fuse, the motion detector employs a lighthouse ube as an oscillator. A low-power beam at 2450 megaycles is radiated from the device, so that a nearby bject moving forward or backward in the beam operates a relay. It will operate through partitions of brick, ood, wall board, or plaster, and is expected to find ndustrial applications.

Man-made Lightning . . . *Largest Center*

The world's largest man-made lightning center was nder construction during the year at Pittsfield (Mass.), ith completion expected next March. The old laboraory, where 10,000,000 volts were generated for the rst time by man, will continue to be used for lightning esearch at lower voltages. The new, larger laboratory ill afford more space for high-voltage experiments on arger equipment, including transformers, lightning rresters, capacitors, and bushings. For experiments on quipment too large for even the new building, there ill be an outdoor testing area, 60 by 120 ft. Principal lements of the equipment for the new laboratory will e two 5,000,000-volt impulse generators to supply the 0,000,000-volt discharges. (Lightning may impose n transmission lines voltages limited only by flashover.) here will also be a 1,000,000-volt 3-phase 60-cycle ransformer set, capable of delivering 1,750,000 volts to round. The old laboratory will be re-equipped with maller impulse generators.



A leak detector is here being used on a refrigerator production line for testing the piping system

TESTING

AND MEASURING

TESTING EQUIPMENTS

Differential Analyzer . . . *442 Times as Fast*

MATHEMATICAL problems will be solved more quickly at the University of California, Los Angeles, by means of a differential analyzer (**Fig. 3**) placed in operation during the year. The first calculator of its type to be built on a commercial basis, it follows the design of the initial machine the Company built for its own use several years ago. During the war, that machine was invaluable in studies involving radar, hydrodynamic flow, rotating machinery, airplane stresses, and speed governors. More recently it was used in obtaining trajectory data for firing V2 rockets at White Sands (N. Mex.). In one instance it was estimated that in two weeks this analyzer accomplished work equivalent to 17 man-years of effort—a matter of 442 times the speed.

The U.C.L.A. machine will be able to handle such complex problems as the analysis of fluid-flow problems for steam turbines and gas turbines, the determination of torque and of current oscillations in motors following transient disturbances, and the study of airplane landing shocks too destructive to be carried out in actual practice.

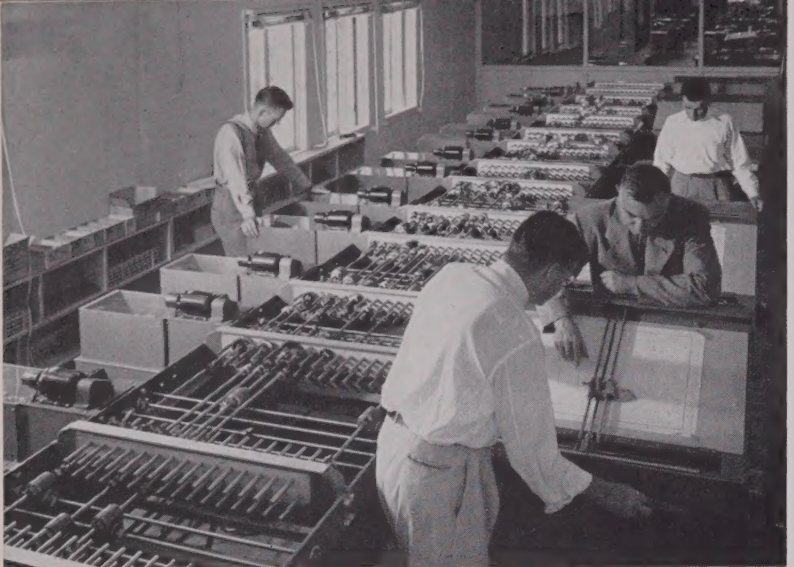


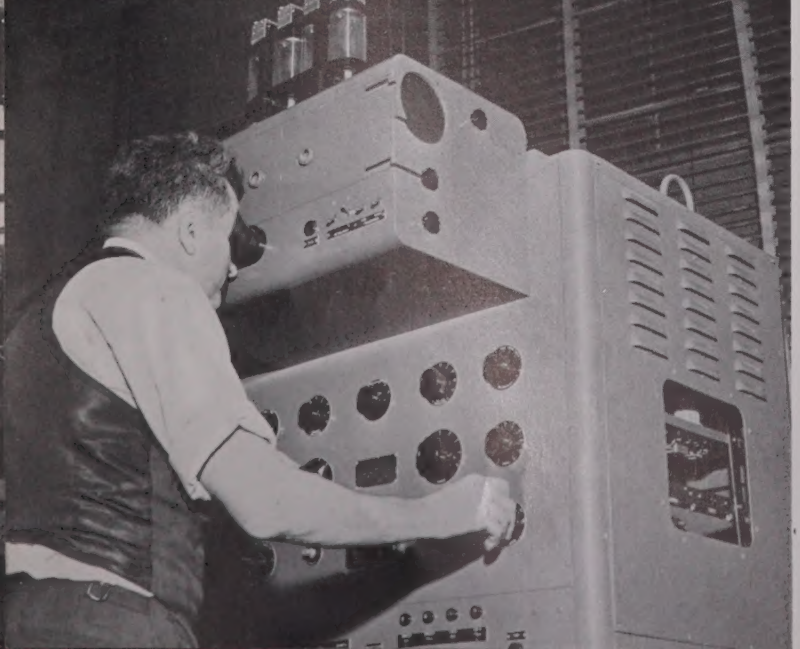
Fig. 3. This differential analyzer, shown installed at the University of California, Los Angeles, can accomplish in two weeks mathematical computations equivalent to 17 man-years of effort

Rockets . . . *All Resources*

Investigations in the fields of aerodynamics, rocket-motor design, propellents, electronics and controls were being carried on simultaneously during the year in an extensive rocket research program being conducted for the War Department by Research Laboratory, General Engineering and Consulting Laboratory, and Electronics Laboratory personnel. Among the developments was a new telemetering device for returning scientific and operating information from the speeding missile to the ground, and a "flight simulator" for ground testing of rocket controls.

A test station which will static-test rocket propulsion motors up to 50,000 lb thrust, equivalent to 500,000 hp, erected near Schenectady as part of the General Electric-U.S. Army Ordnance Department joint long-range rocket research program, contributed valuable data for basic rocket-motor design and fuel development.

Fig. 4. With this new high-speed recording cathode-ray oscillograph, which develops and projects a picture in 24 sec, it is believed the time required for making impulse tests on electric apparatus and insulation can be reduced to about 1/10 that ordinarily required



Dynamometers . . . *Problem Solve*

One problem confronting the Army Proving Groun staff at Aberdeen (Md.), was accurate determinatio of the tractive effort of heavy tanks. Measuremen of short time intervals to a very high degree of accurac and high-stress measurements were called for, addition to more usual dynamometer-car measurin equipment. Complete instrumentation was furnishe for a unit which will withstand forces of 400,000- magnitude. A high-speed electronic counter and highly accurate oscillator to furnish a known numb of timed pulses to the electronic counter are used indicate exact periods of time.

METERS AND INSTRUMENTS

Electrical Measurements . . . *Fast Developi*

INKLESS recorders were previously produced only portable cases; now there are semiflush switchboa models, in aluminum-drawn-metal cases of 12 by 8 in. frontal dimensions. A single-phase wattmeter w added to both the portable and switchboard lines.

A new watt-var meter for 400-cycle circuits emplo a principle of operation which permits use of a standa wattmeter mechanism, thus simplifying manufactu and maintenance. The meter has a 1⅞-in. dial.

For rapid testing with high-voltage surges, a tw element cathode-ray oscillograph and camera inco porating automatic developing and projecting w produced (**Fig. 4**). Camera and projector design w worked out in collaboration with the Eastman Kod Company. The camera speed and cathode-ray bea intensity are high enough to give good records surges with wave fronts of a microsecond or less. T record is taken by pushing one button, and the d veloping mechanism is started by pushing anoth Development is complete in 24 sec, and then the fil is shifted into the projector, where it may be observ and measured at the same size as originally seen on t cathode-tube screen.

With the advent of the change from International Absolute Units taking place at the end of the year, precision resistance thermometer bridge (**Fig. 5**) the Mueller type, reading in Absolute Ohms, was ma available. It is of the six-dial type with a range 111.111 ohms and can be read to 0.0001 ohm. The fi three dials are of gold-chromium alloy with negligib temperature-coefficient of resistance, thus eliminati the need of thermostatic temperature control.

Frequency and tie-line load, according to the mo modern theories, are two vitally important variab which must be accurately controlled in efficient operated interconnected power systems. Such a cont was completed for a large foreign system. Provisi was made for continuous automatic frequency cont biased by the tie-line load. Automatic adjustment this bias over a considerable range permits operati under widely variable conditions of system pow interchange. A standard-frequency source furnish several kilowatts to operate clocks, recorders, etc. T

e-line load signals are received over telemeter chanels and, by use of a new photoelectric bias control, re converted into a continuous signal whose magnitude nd polarity regulate the amount of tie-line load bias pplied to the frequency control.

A variable-frequency power supply, for magnetizing ermanent magnets, for demagnetizing, and for magetic testing, consists of a discriminator panel, vacuumube amplifier, power supply, and selsyn train; a 25-kw notor-amplidyne set is also required. The system will roduce an output having a variable frequency range rom 0.00167 to 5 cycles per second. At a frequency of cycle the output is 250 volts with a load of 25 kw. 'he voltage waveshape distortion is less than 10 per ent with an inductive load.

Special test equipments were needed in the manuacture of drive units for an automatic washer. It was

Fig. 5. A new resistance thermometer bridge being used to check a resistance thermometer. This new bridge utilizes gold-chromium alloy coils in the lower anges, thereby reducing the temperature coefficient to a negligible value. The ridge is calibrated in the new standard absolute units rather than the obsolete nternational scale

lesired to perform rapidly a number of production ests and obtain suitable data for quality control. Equipment was built that could make a series of nine ests in 60 sec. Included are dynamic torque, resistance, nd power measurements and high-voltage insulation ests. The measurements are taken under different onditions of operation: stalled; running; loaded; and nloaded. Effective testing is possible at a high proluction rate.

An electronic microammeter (**Fig. 6**) has improved he method of measuring insulation resistance of lielectrics while under high-voltage d-c stress. Normally n such tests the stress applied to the sample is measured with a voltmeter and the current through the nsulation with an ordinary microammeter; a sudden ailure of the insulation may result in burning out the

Fig. 6. A newly developed electronic microammeter being used for insulation measurements on the transformer in the desiccator. This new instrument, unlike the usual microammeter used for insulation testing work, is not damaged by an overload, and hence makes for simpler testing

current-measuring instrument. The new electronic microammeter withstands the overloads caused by arcovers or failures of the sample.

Mechanical Tests . . . *For Square Rods*

A pneumatic fatigue machine was specially adapted for testing one-inch-square drill rod. The sample, 30 in. long, is vibrated in a horizontal position and mounted in a free-type suspension. The frequency range is 160 to 275 cycles per second. The stress produced is sufficient to break the bar in 15 to 20 min. Controls are mounted in a separate steel cabinet away from the machine, allowing the operator to spend most of his time away from the fatigue motor.

Metal parts and stocks appearing alike but differing in composition are separated quickly and easily with a new metals comparator (**Fig. 7**). Operation of the instrument, which employs a balancing electric network, is nondestructive and can be carried out effectively

Fig. 7. As many as 1500 small parts can be checked for composition or hardness in an hour with this metals comparator

for either magnetic or nonmagnetic materials. The comparator has been used to differentiate between annealed and unannealed steel bars and also to sort finished metal parts on the basis of composition or heat treatment.

An equipment meeting the new speed, torque, and accuracy requirements of present development work on steam turbines, gas turbines, compressors, etc., was developed. Speeds up to 35,000 rpm are encountered. The high-speed electromagnetic torque meter permits the measurement of torque without any power absorption, provides continuous load transmission and torque measurement, and eliminates cradling of the prime mover or load. It has an accuracy of ± 1 per cent of full-scale reading and has a repetitive accuracy of ± 0.5 per cent. The torque meter is, essentially, a transmission dynamometer and measures the torque transmitted through a rotating-shaft system.

Fig. 8. A photographic exposure meter "with a memory"

To indicate the presence of voids, cracks, porosity, laminations, poor bonds, and other internal flaws in metals, plastics, and ceramics, there was introduced an ultrasonic materials tester. It sends a beam of ultrasonic waves through the specimen under test; changes in the amount of energy transmitted through the specimen indicate presence and extent of flaws. The instrument can also be used to indicate changes of viscosity, compressibility, and density of liquids when these significantly alter the velocity or attenuation of ultrasonic transmission.

Chemical Tests . . . *Process Control*

To the mass spectrometer and its variant, the leak detector, there was added during the year a process-control spectrometer, especially designed to continuously monitor and control a process stream by automatic periodic sampling and measurement of certain predetermined constituents. It is possible to keep a continuous check on the presence of as many as eight individual components of a mixture. The instrument has been used with notable success to monitor process streams of mixed gases for such ingredients as oxygen, hydrogen, carbon dioxide, hydrogen fluoride, and nitrogen. Where the ingredients are such as to produce significant peaks on the recorder, it is possible to extend the monitoring to include automatic process control.

In mass-spectrometer-type instruments, a gas is ionized and the ions are accelerated through a magnetic field which causes them to follow circular rather than straight paths. The heavier molecules are deflected less than the lighter ones and, by proper positioning of a collector, ions of any desired molecular weight can be separated from those of other weights. The basic analytical mass spectrometer was originally a special laboratory instrument but more recently has been redesigned for commercial use. Its variant, the leak detector, is essentially a mass spectrometer particularly sensitive to helium. Its operation involves blanketing a section of a piping system with helium and then testing the gases flowing inside the pipes.

Many uses are indicated for the previously announced x-ray photometer. One is in determination of the amount of tetraethyl lead (anti-knock compound) in gasoline. Measurement can be made in five minutes, including weighing the sample in the test cell. The sample is not damaged, so the measurement can be checked repeatedly if desired. Chemical determination would require two hours and would destroy the sample. Other possible uses include measurement of sulphur in oil, silver, and other metals in solutions and, in general, measurement of any element of high atomic number in combinations or mixtures with elements of low atomic numbers. Present photometers use liquid samples, but solid or gaseous samples can be measured by suitable modifications.

Timers . . . *Wide Range*

A new low-price general-purpose time switch was given an extremely wide timing range—minimum setting of five minutes and maximum of 22 hr. It is single-pole, single-throw, and incorporates a self-starting permanently lubricated Telechron motor. Terminals are large and clearly marked, and five convenient knockouts make installation easy.

Light Measurements . . . *New Exposure Meter*

Several new features were introduced in a photographic exposure meter (**Fig. 8**): a pointer-locking mechanism which "remembers" the light seen by the photocell; a louver-coupled dial which "remembers" to shift the meter automatically from high light to low and back again as the scene requires; and a trident analyzer which "reminds" the photographer to check the range of light on the subject. Because of these features, the "meter with a memory" is operated simply by pressing a button, setting the trident in line with the pointer, and reading the proper exposure.

It clearly shows a complete range of combinations of f-stops and shutter speeds. It can be shifted for movie use, and the proper exposure is then shown for all makes of movie cameras. The meter is small enough to fit in a vest pocket.

the foreground the two-studio consolette used at Syracuse Uni-rsity's 2.5-watt experimental "educational" FM broadcast station rving campus and student homes nearby

ELECTRONICS

. . . . . .

RADIO TRANSMITTERS

AN ESSENTIALLY complete line of broadcast transmitter equipment, all of which may be ap-lied without change for either domestic (60-cycle) or xport (50-cycle) service, was a major engineering ob-ective of the year. The four main categories included M broadcast transmitters, antennas for FM trans-itters, standard AM broadcast transmitters, and udio facilities for both AM and FM broadcast studios.

M Transmitters . . . *Phasitron*

The heart of the FM broadcast transmitter line is the hasitron modulator (**Fig. 9**), based on development ork by Dr. Robert Adler of the Zenith Radio Cor-oration and pioneered commercially by G. E. This ystem produces frequency modulation electronically nd permits the carrier center-frequency to be con-rolled directly by a quartz crystal in conventional nanner. A marked reduction in number of tubes and ircuits is thus achieved.

The phasitron modulator is the driver for trans-nitters of the standard ratings of 250 watts, and 1, 3, 0, and 50 kilowatts, operating in the "high band" of 8 to 108 megacycles. This band, assigned by FCC ince the war, is about twice the prewar frequency ssignment of 42 to 50 megacycles. All equipments are ir-cooled. Final amplifier stages operate "push-pull," with tetrodes for the 250-watt and 3-kw equipments and riodes for the other ratings. The transmitters through 0 kw are completely self-contained. A styled "building lock" mechanical arrangement permits the broad-caster to increase power at a later date and utilize all his original equipment; the 10-kw transmitter, for example, consists of the basic 250-watt exciter, followed by the 3-kw and 10-kw amplifiers.

The phasitron modulator constitutes a small 2½-watt FM broadcast transmitter proposed for small-budget applications in schools and colleges. Such a transmitter was installed at Syracuse University and operated experimentally. It has the high-fidelity characteristics of larger equipments, and the low power is sufficient to cover the college campus and surrounding student homes. Regular student operation of such an educational station, with associated studio facilities, supplements classroom instruction and is a highly successful means of learning-by-doing in all phases of broadcast programming and operation.

FM Antennas . . . *New "Doughnut"*

The multi-bay circular or "doughnut" antenna, a prewar development to provide a useful range of power gains in the horizontal plane, was redimensioned for the new frequency band in all sizes: 1-, 2-, 4-, 6-, and 8-bay. Corresponding power gains range from 0.79 to 7.24, thus giving the broadcaster a wide choice of antenna gains as well as transmitter ratings to achieve his licensed effective radiated power.

AM Transmitters . . . *Packaged Units*

"Packaged units" were designed in the standard ratings of 250 watts, and 1, 5, 10, and 50 kw in the AM transmitter line. All ratings feature high-level Class B modulation, with ample use of feedback for highest-quality performance. Forced-air cooling is used. Many of the design features have been time-tested in the 100-kw international (short-wave) broadcast transmitters which saw rigorous service on four continents during the war. The 100-kw equipment is also in production.

Fig. 9. The phasitron modulator, for producing frequency modulation electronically, is the heart of FM broadcast transmitters of all power ratings

Audio Facilities . . . *For Both AM and FM*

An important addition to audio facilities equipment was a commercial design of an improved limiting amplifier, early development of which was performed by E. E. Schroeder of the Columbia Broadcasting System technical staff. This rack-mounted amplifier is designed to permit a very substantial increase in average program level of broadcasting and recording systems without danger of any peak exceeding a predetermined maximum value. It has substantially instantaneous attack time, and recovery-time duration is automatically adjusted to the nature of the "overload."

TELEVISION

A NEW television studio camera, utilizing the image orthicon tube, produces television pictures that are sharp, clear, and with details in both the high lights and shadows without need of high general lighting. The telescopic pedestal is foot-controlled, and the camera is spring-counterbalanced for easy and smooth tilting. A turret lens mounting is provided for quick focus change. The camera (**Fig. 10**) has a wi range, both vertically and horizontally, for full stud coverage. Use of new miniature tubes has permitte compact design; quick-drop side shields and top ma maintenance convenient.

Fig. 10. One-man operation features this new television studio came minimum controls on the camera allow the operator freedom to give t greatest possible attention to the "show"

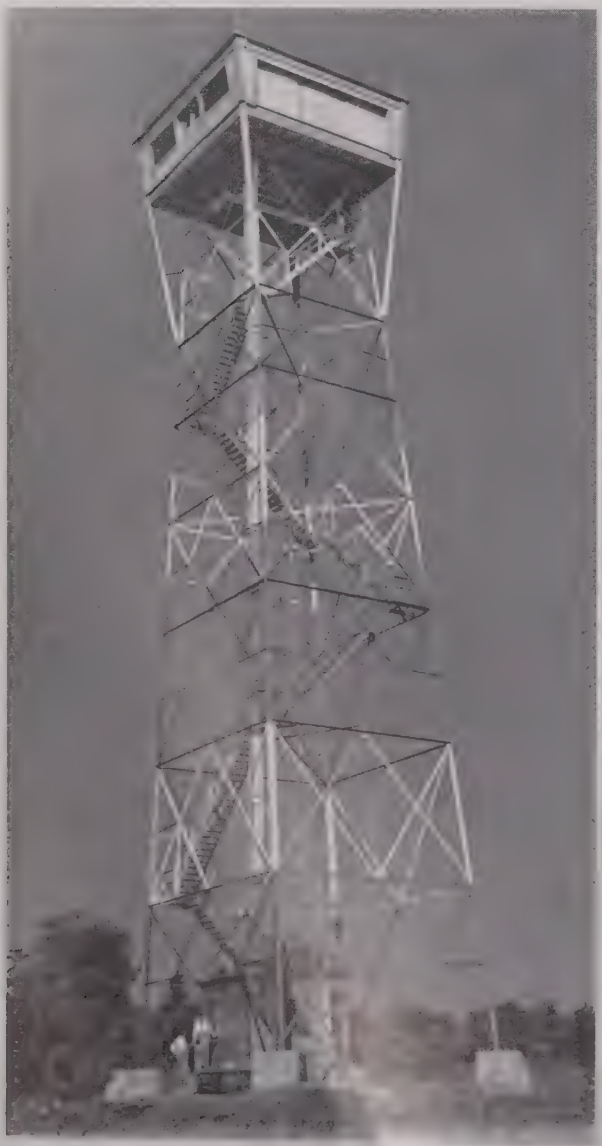


Fig. 11. One of the relay towers in the four-link microwave relay system between New York City and Schenectady

A four-link microwave relay system (**Fig. 11**) w placed in operation between New York City an Schenectady to supply television programs for Statio WRGB at Schenectady. Programs from any of t New York City television transmitting stations may picked up at the terminal in the General Electr Building, in New York City, and relayed. A simil three-link microwave relay system was installed b tween South Bend (Ind.), and Chicago for the Balaba and Katz Corporation to permit broadcasts of Not Dame football games from Chicago.

ELECTRONIC TUBES

Industrial Tubes . . . *One-cycle Acti*

TO PROVIDE power supply for broadcast station induction-heating applications, and laboratori employing cyclotrons and synchrotrons, a pool-type tu was designed with a control grid which enables it bo to regulate current and to provide one-cycle circui breaker action, and with a potential-dividing grid lower the voltage gradient between the anode and t cathode. Six tubes will rectify up to 3000 kw at 20,0 volts. The tube is a stainless-steel-jacketed ignitr with a peak inverse or forward voltage rating of 20,0 volts and a current rating of 200 amp peak, 50 a average.

Only one minute is required, instead of five, f cathode heating in a new design of quick-heating ine gas-filled thyratrons for motor-control, welding-contr

nd other industrial applications. The tube can operate ver a very wide temperature range—minus 55 to plus 0 C; former mercury tubes for the same application equired a five-minute cathode-heating period and were estricted to a condensed-mercury temperature of 40 to 0 C. The tube has a rating of 1500 volts peak inverse nd 6.4 amp, average.

Six kilowatts of power at frequencies up to 50 megacycles, for dielectric-heating use, are supplied by a orced-air-cooled high-vacuum tube. A pure-tungsten lament permits reduction of filament voltage during eriods of no plate power, thus adapting the tube to ntermittent service.

ransmitting Tubes . . . *For High-band Use*

For the new high-band television broadcast wavength, there was introduced a new forced-air-cooled ube with output of 1150 watts, operating at frequenies as high as 220 megacycles at maximum ratings. uch a tube is used as an intermediate amplifier in the ew five-kilowatt television transmitter for this wave and.

Fig. 12. Three new miniature tubes for FM and television receivers

Receiving Tubes . . . *One for Two*

Three nine-pin miniature tubes (**Fig. 12**) were developed especially for use in FM and television receivers. Two of them contain a triode section and three high-perveance diodes in one envelope. This design enables a single tube to perform the functions of FM and AM detection and first-stage audio-frequency amplification in a-c/d-c or a-c receivers where two tubes were previously required. The third tube is a twin-triode for converter service at frequencies as high as 300 megacycles.

Special Tubes . . . *Highly Sensitive*

A new high-vacuum electrometer tube for use as a very sensitive measuring device differs from previous types in that the control grid and anode have each been divided into two parts. This compensates for variations in filament emission, giving the tube higher current sensitivity and a greater degree of stability than can be obtained with single-electrode construction. Used in a Wheatstone bridge circuit with a 10^{11}-ohm grid resistor and a 10^{-10} ampere-per-millimeter galvanometer, a sensitivity of approximately 75,000 millimeters per volt can be obtained.

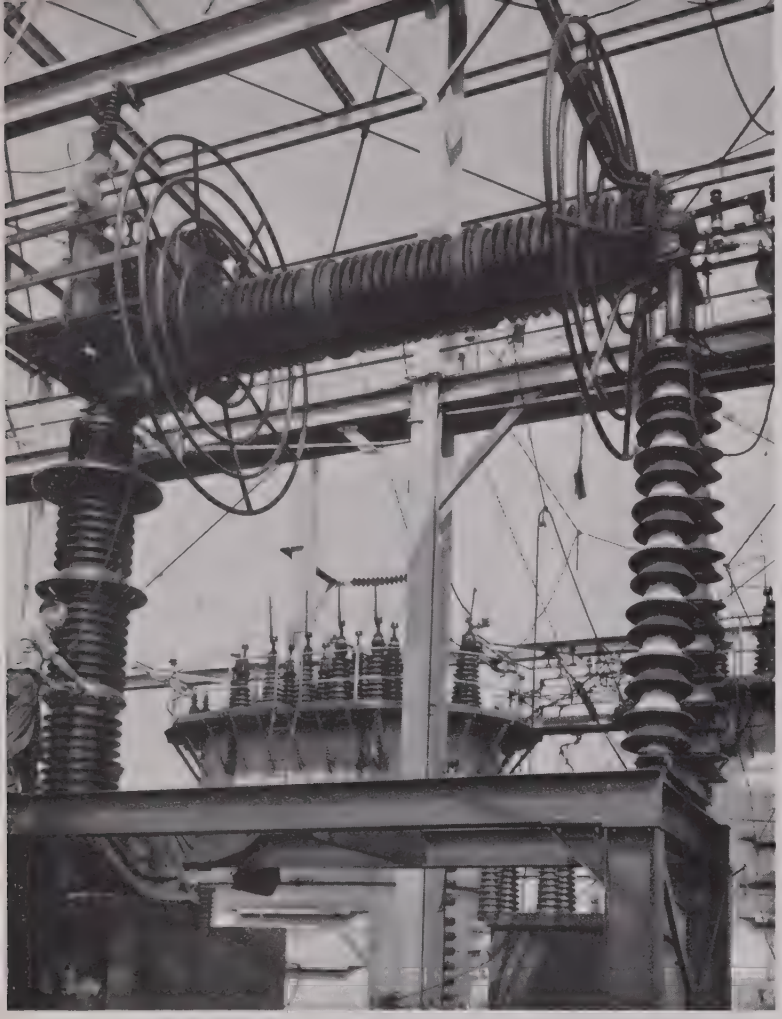
Shaken 25 times every second for 100 hours, 8,000,000 shakes at an acceleration faster than that which makes a pilot "black out"—traveling 1000 mi in quarter-inch creeps, back and forth on the same path—that is the treatment given electron tubes in this vibration test machine

MEASURING EQUIPMENT

A NEW signal generator for the radio-service man combines in one compact equipment four units: radio frequency oscillator; an FM oscillator; a crystal calibrator; and a variable-frequency audio oscillator. With these signals available, it is possible to service completely both AM and FM receivers accurately with minimum time, equipment, and investment.

A new decade scaling unit is intended primarily for use in nuclear research, in the counting of radioactive particles. It can also be used for the accurate counting of many rapidly recurring events, such as the number of cycles in high-frequency waves, as a high-speed timer, or in conjunction with calculating machines.

The 100th anniversary of Edison's birth, marked during the year, called attention to the famous inventor's discovery of thermionic current in 1883. Here Robert Watson, electron tube engineer (left) and Dr. Irving Langmuir, Nobel prize winner, each has a "lighthouse" tube developed for radar during the war. On the table, in the center, is a replica of Edison's original tube; in front of Dr. Langmuir is his own high-vacuum tube which he developed in 1912



The highest-voltage and highest-capacity power circuit breaker ever built. It will handle up to 500,000 volts, has an interrupting rating of 10,000,000 kva. With a total interrupting time rating of three cycles (1/20 second), it is designed for high-speed reclosing service

POWER

GENERATION TRANSMISSION DISTRIBUTION

POWER GENERATION

Turbine-generator Sets . . . *Temperatures Up*

OPERATING temperatures, and hence operating efficiencies, of steam turbines have been increasing. Before the war a 25,000-kw turbine was built for 1000 F but, because of boiler limitations, was never operated at that temperature. During the past year three more 1000 F units were delivered, and six others were under construction. Also being built were six units totaling 700,000 kw with initial temperature of 1050 F.

Now that successful operation in the 900- to 950-F range has been demonstrated in installations totaling more than four million kilowatts, attention is again focused on the advantages of the resuperheat cycle, originally sponsored at Schenectady at the 700F temperature level. Five turbines totaling 580,000 kw are under construction for operation with initial and resuperheat temperatures of 1000 to 1050 F. Some ne stations will deliver net power at less than 10,000 Bt per kw-hr.

Among the most significant turbines under co struction, in addition to the two 100,000-kw, 3600-rp Sewaren machines reported last year, are the thre 125,000-kw cross-compound units for the Philip Spo Station of the Appalachian Electric Power Compan They will have initial steam conditions of 2000 lb gag and 1050 F, with resuperheat to 1000 F and an absolu back pressure of 1-in. of mercury. The 3600-rpm hig pressure element will exhaust into a resuperheate The 1800-rpm low-pressure element is a tande compound, double-flow design. These units will u seven stages of feedwater heating. They will be rivale in fuel economy only by the 40,000-kw mercury-stea installation under construction for the Public Servi Company of New Hampshire, at Portsmouth (N. H.

First of its size for service at 1250 lb gage will be t 150,000-kw 1800-rpm tandem-compound double-flo turbine for the Fisk Station of the Commonwealt Edison Company of Chicago; it will have a maximu capacity of 165,000 kw and will operate at 1250 gage and at 925 F initial temperature. Of similar desig and capacity, but operating at 950 F, will be one f the Richmond Station of the Philadelphia Electr Company; it will have five stages of feedwater heatin

Two 120,000-kw cross-compound units for the Ea River Station of the Consolidated Edison Company New York will have steam conditions of 1450 lb gag and 1000 F initial temperature for the 3600-rpm hig pressure elements. The low-pressure elements will double-flow 1800-rpm machines, for an absolute e haust pressure of 1½ in. of mercury.

The initial steam conditions will be 1300 lb gage an 950 F in two 100,000-kw 1800-rpm turbine-generat sets for the Trenton Channel Plant of the Detro Edison Company. These will be tandem-compoun double-flow units.

The 80,000-kw 3600-rpm resuperheating turbine f the Buffalo Niagara Electric Corporation represents new design for resuperheating at 1000 F. The initi pressure is 1450 lb gage.

A milestone in the development of 3600-rpm ge erators was established by the completion and shipme of a 95,000-kw 0.85-power-factor hydrogen-cool generator (**Fig. 13**) for the Essex station of the Publ Service Electric and Gas Company, in New Jerse This is the largest generator so far built for this spee Its 100,000-kw 3600-rpm turbine operates at 1250 gage and 1000 F initial temperature. Another hig pressure unit is the 50,000-kw 3600-rpm turbine for t Sherman Creek Station of the Consolidated Edis Company of New York, for service at 1600 lb gage an 950 F initial temperature.

Substantial progress was made in the simplification auxiliary equipment used with hydrogen-cooled turbin generators, particularly in the smaller sizes up to abo 30,000 kw. The vacuum-treating apparatus for the used in the shaft seals is no longer required in those size

Diesel-driven Generators . . . *They're Bigger*

Since the war's end there has been a trend to larger diesel-driven generators. The Chilean Nitrate Company has received a low-speed machine (FRONTISPIECE) rated 7050 kva 5000 kw 164 rpm. Another, shipped to the Iowa Light and Power Company at Marshalltown (Iowa), has a rating of 6813 kva, 5450 kw, 164 rpm, and 4160/2400 volts. Even larger are a half dozen under construction for Mexico. These will be rated 7500 kva, 6000 kw, 167 rpm, and 6300 volts.

Power Station Auxiliaries . . . *Enclosed Motors*

Enclosed motors with top-mounted surface air coolers were under construction in increasing quantities for use in power stations. The enclosure keeps the motor windings clean, reduces noise in the station, and simplifies the ventilating requirements of the room, since the release of a considerable amount of heat into the room is eliminated. The air-to-water heat exchangers are mounted on top of the motors, simplifying the base and the building-floor construction—permitting the use of a normal-design common base for motor and pump and allowing the floor plan to be designed from the standpoint of strength requirements. For use with boiler feed pumps there were twenty 3600-rpm motors being built for service in power stations, from 1500 to 3000 hp in size, and all with top-mounted coolers. Two 720-rpm 2000-hp motors for draft-fan drive and one 900-rpm 800-hp motor for gas-blower drive in a steel mill likewise will have their coolers on top.

TRANSFORMERS

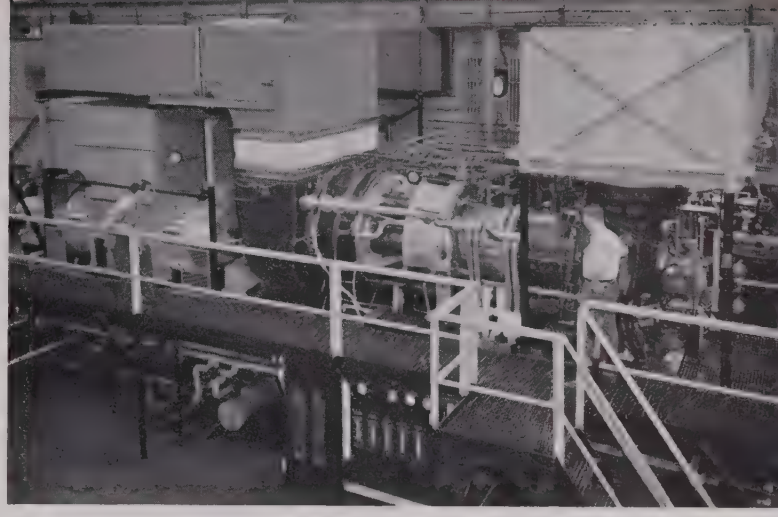
Power Transformers . . . *Voltage Up*

FOR purposes of design development, which can logically justify overreaching the accepted range of commercial requirements, a grounded-neutral power transformer has been built with a 360,000-volt winding. The new transformer (**Fig. 14**) has a 60-cycle, self-cooled, continuous rating of 10,000 kva at a winding-temperature rise of 55 C. It successfully passed the standard impulse tests corresponding to a basic insulation level of 1,550,000 volts. The high-voltage bushing is liquid-filled and is considerably larger than any previously made by the Company, being rated 360,000 volts, 400 amp, and having an over-all length of 26 feet. The highest-voltage power transformers built previously at the Pittsfield Works were the 287,500-volt units for Hoover Dam.

One of the largest commercial transformers built during the year (**Fig. 15**) had to be shipped by unorthodox means. Rated 60,000/75,000 kva, 132,000 GrY/13,500 volts, it was necessary to dismantle the huge tank, ship it by rail in two parts to the north New Jersey shore, and then transport it by barges to the Sherman Creek Station of the Consolidated Edison Company, on the Harlem River in upper Manhattan.

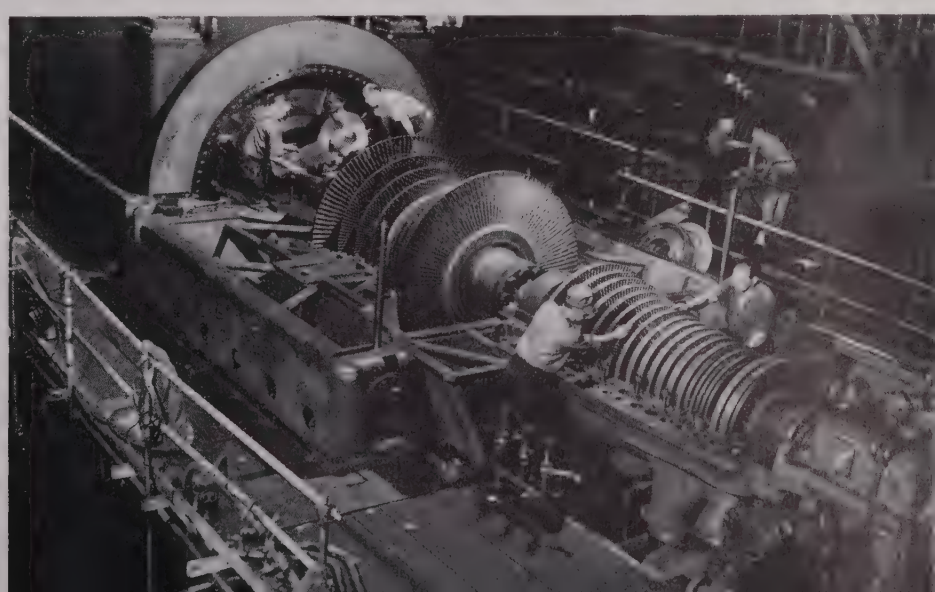
Specialty Transformers . . . *Aluminum Primary*

Precision winding of primary coils, permitting use of aluminum wire, was an engineering achievement of importance for luminous-tube transformers. The winding method eliminates need for layer insulation, so that using aluminum wire actually reduces the size of the primary coil, cuts the weight to one third that of a copper coil, and does not increase the temperature rise of the coil. The coil is Formex wire, and the softness and



A 4800-hp gas turbine power plant, Schenectady's first for nonaircraft service, is here shown undergoing elaborate test runs in the factory

Fig. 13. This stator of a 95,000-kw generator for a New Jersey station weighs 185 tons, and was the largest single piece of equipment ever shipped from a G-E plant



Assembling a 50,000-kilowatt turbine-generator set for test in the factory at Schenectady before delivery to the Ohio River Power Company

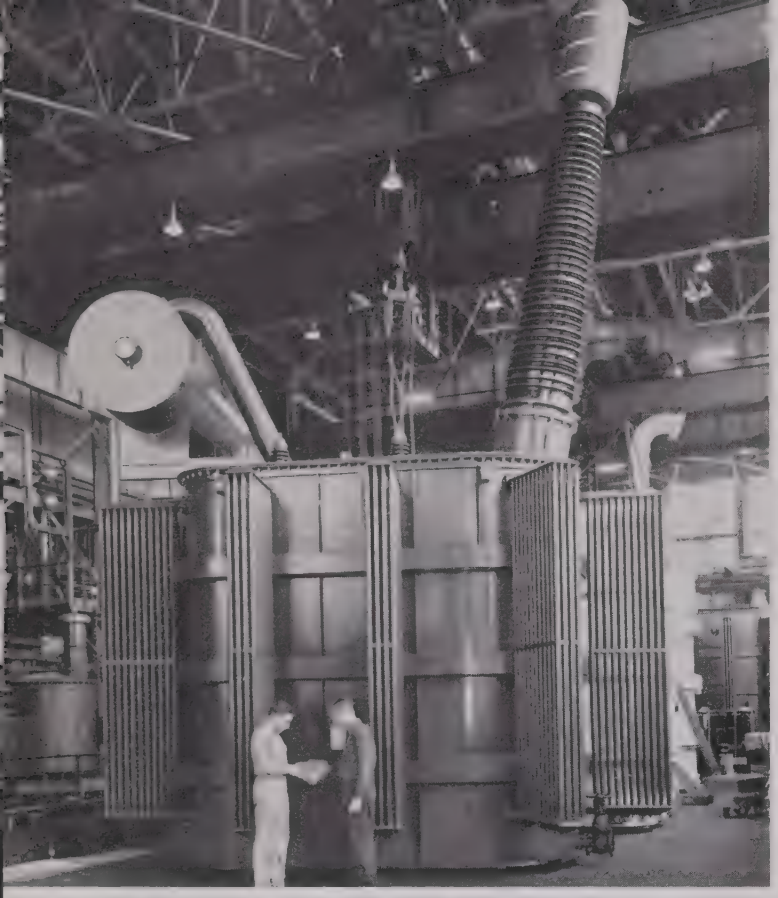


Fig. 14. Highest voltage yet for a Pittsfield power transformer—this unit is for developmental purposes at 360,000 volts. In a 3-phase bank with grounded neutral, line voltage would be about 622,800 volts. The high-voltage bushing for this transformer, with capacitance tap, is 26 ft long.

pliability of aluminum makes it especially suitable for the application.

Inverter transformers for neon-sign operation in trucks, taxicabs, and buses, for either 6- or 12-volt d-c operation, were redesigned so that the life of the inverter is increased as much as 1000 per cent over the previous design. It gives greater light output from the sign at a lower battery-current drain, starts reliably, and offers versatility of application with the basic design.

A new transformer for electronic air filters weighs 61 lb; its predecessor weighed 105 lb. It incorporates the spaced-winding feature that is used in luminous-tube transformers and thereby suppresses the deteriorating effects of high-voltage corona.

The first of a new line of general-purpose inverters, for a wide variety of loads such as ballasts for fluorescent lamps, motors, etc., has a rating of 100 volt-amperes, 115 volts, 60 cycles, from a 24-volt d-c source. It is self-stabilized to hold the a-c voltage virtually constant from no load to full load and through wide fluctuations of input voltages. Its special vibrator has a life expectancy of 1500 hr as compared with 500 hr of the previous unit.

Automatic voltage stabilizers in several ratings up to 0.5 kva were redesigned to reduce size and weight greatly and added versatility. Special low-loss steel in the single-core construction increases the operating efficiency. Constant output-voltage within ±1 per cent of normal is obtained over a range of input voltage variations of ±15 per cent. For closer stabilization there are special units. The new equipments are particularly suitable for electronic control circuits.

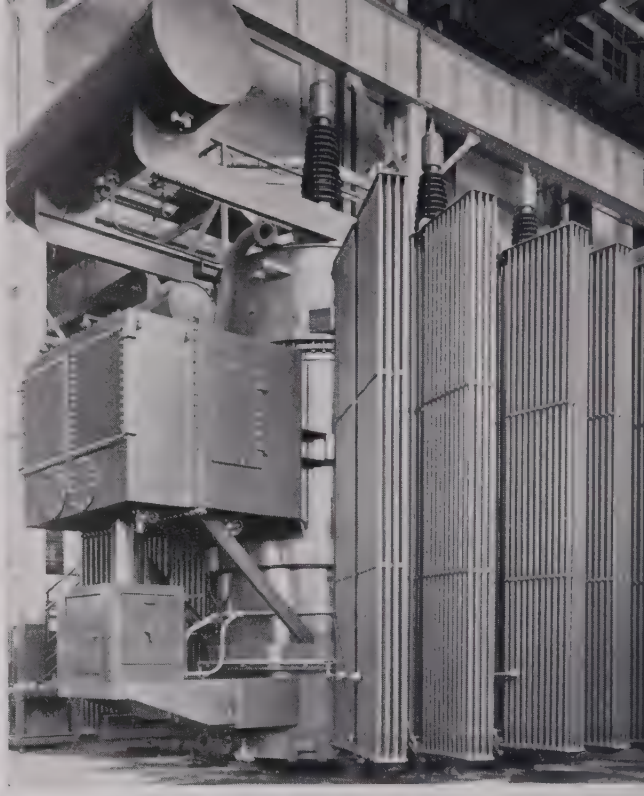


Fig. 15. Shipment to Manhattan was a problem with this power transforme one of the largest built during the year

HIGH-VOLTAGE TRANSMISSION

POWER requirements are ever increasing; highe transmission voltages are being given serious cor sideration. For the super-high-voltage Tidd test lin being built by The American Gas and Electric Co poration at Brilliant (Ohio) there was developed three-phase substation equipment including oil circu breaker, air-break disconnecting switches, bushin current transformers, lightning arresters, structura steel, etc. All component parts are rated 360,000-vo normal operating voltage, 800-amp continuous curren (highest transmission voltage today is Hoover Dam 287,000 volts). The over-all equipment has an in pulse-insulation-withstand level of 1,300,000 volts.

The power circuit breaker is of the low-oil-conten impulse type, with six breaks in series in the horizont porcelain interrupters. It is operated by compressed ai

Also being furnished are Thyrite lightning arreste to protect the high-voltage switching station. Inte changeable units are placed in series to obtain an desired voltage rating. Each unit is complete with i series gap and valve elements in a porcelain housin with end-fittings suitable for bolting adjacent uni together. The lower-voltage arresters are bas mounted; each 25-unit stack for the high-voltag developmental line is of the suspension design. Th units are supported by strain insulators from the st tion metal structure, with a grading ring at the lin end to provide the desired voltage distribution.

The extremely high transmission voltage also cal for special insulators, which have been designed b the Locke Insulator Corporation of Baltimore, a G affiliate. Involved is a new conductor clamp suitab for supporting the large hollow conductors used on th

rcuit. The clamp is articulated to minimize hazards conductor vibration and fatigue. For such high voltes, special precautions were taken to control corona ound the conductor clamp and line insulators (**Fig. 16**). Two new fog-type suspension insulators were anunced during the year by Locke. They are designed rticularly for use in areas subject to severe atmoseric contamination.

The Fred M. Locke Ceramic Research Laboratory as completed at Baltimore during the year, greatly larging the facilities available for research in the ramic field.

SWITCHGEAR

THE maximum short circuit available on the Grand Coulee system—7,100,000 kva—was applied to standard conventional tank-type oil circuit breaker "small tank" design (**Fig. 17**) and to a low-oil-ntent impulse-type breaker (**Fig. 18**) in tests made the spring. A total of 38 tests, with values varying om 500,000 to 7,100,000 kva, were made on the eakers, both of which were rated 230 kv, 3,500,000 a. Tests were made with high-speed reclosing of 20 cles or less, without any disturbances or distress to y part of either breaker.

rounded Enclosures . . . *Safety, Continuity*

Safety to personnel and continuity of electric service re major objectives in the design of the newly opened 338,000-kva Southwark Plant of the Philadelphia Electric Company. All of this switchgear is fully enclosed in grounded metal, and all interrupting devices are of oilless type.

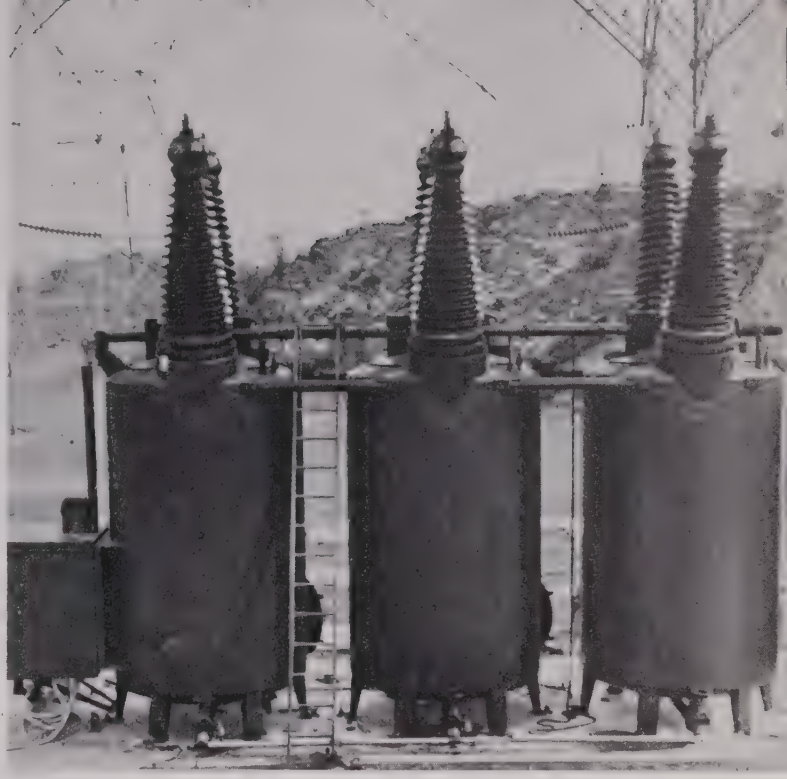
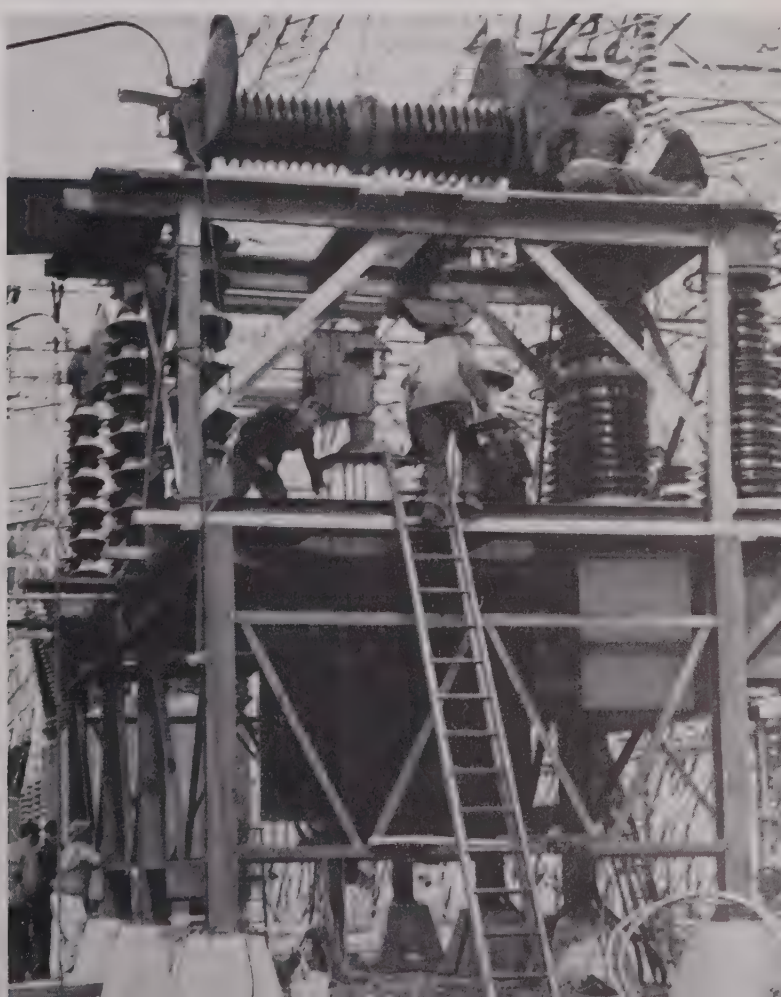


Fig. 17. A standard tank-type oil circuit breaker, rated 230 kv and 3,500,000 kva, which handled all the available short circuit at Grand Coulee—7,100,000 kva—without disturbance or distress

Fig. 16. Half-million-volt power transmission requires insulator, corona shield, and clamp assembly of new design. The conductor is hollow

Fig. 18. They looked in vain—for any signs of trouble after this impulse-type breaker was subjected to the severest test possible at Grand Coulee



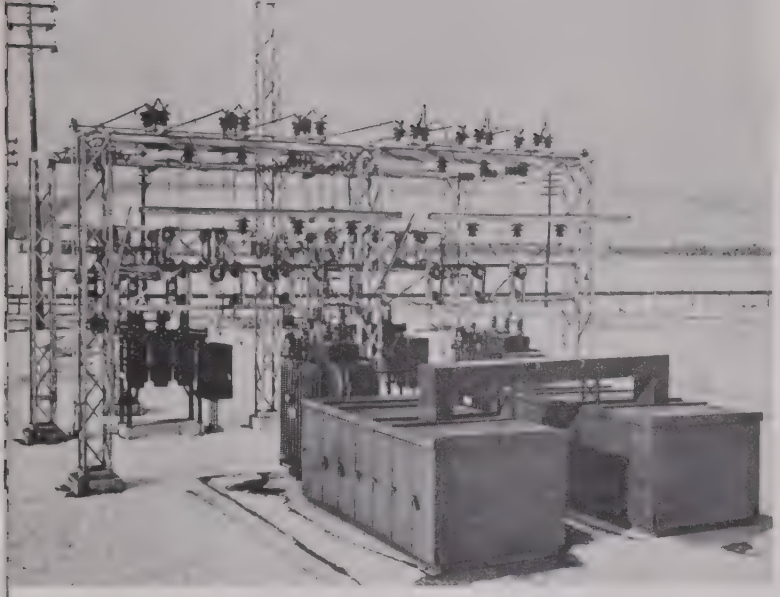


Fig. 19. The first installed package substation, receiving power at 33 kv and distributing it on four feeders at 4160 volts

Metal-enclosed load centers with drawout-type air circuit breakers right in the heart of utilization localities take care of the 480-volt feeders. Metal-clad switchgear with magne-blast air circuit breakers control and protect the 4000-volt station circuits. Metal-enclosed cubicles with high-capacity air-blast circuit breaker are employed in the main 13,800-volt generator and interconnected bus and load lines.

High-voltage D-c Switchgear . . . *Complete "Package"*

One of the first completely factory-built metal-enclosed switchgear for high-voltage d-c circuits was placed in operation at an open-pit copper mine, supplying 1600-volt direct current for the ore-hauling locomotives. Included are two structures assembled back to back to form a complete "packaged" equipment. The front structure mounts the secondary and control devices; the main current-carrying high-voltage devices are in the other. All parts are metal-enclosed except the high-speed air circuit breakers which are each enclosed in a removable compound box mounted above the metal disconnecting-switch compartment. Interlocks prevent operation of the disconnecting switches until the breakers are open. The high-voltage ammeter and voltmeter, visible from the operating front, are on a stationary compound base, and are viewed through a window in the hinged panel.

Low-voltage Air Circuit Breakers . . . *Many Advantages*

Reduced floor area, improved appearance, completely self-contained positioning mechanism, ease of operation, and simplicity of component parts were among the advantages of a new design of low-voltage drawout air-circuit-breaker metal-enclosed switchgear.

The draw-out handle trips the breaker (if closed), thus serving as a safety interlock, and at the same time moves the breaker from its normal operating position.

A noteworthy feature of the new breakers is the overcurrent tripping device which makes practical for the first time the design of completely selective low-voltage distribution systems. This tripping device provides accurate and consistent timing.

69-kv Breakers . . . *Field-teste*

Completely sealed bushings, smaller tank diameters improved interrupters with shorter arc lengths, an high-speed reclosing mechanisms as standard equip ment—improvements previously introduced in breaker rated 115 kv and above—were incorporated in lowe voltage classes. Field tests made on such a 69-kv breake at the Siegfried substation of the Pennsylvania Powe and Light Company—the highest capacity 66-kv fiel tests ever made—together with line-dropping tests u to 70 miles of line, indicated generous margins of safety

Horn-gap Switch . . . *Dual Motio*

Dual-motion operation, in which the blade is swun in a vertical arc and rotated to obtain contact pressur features a new high-voltage group-operated outdoo horn-gap switch developed particularly for service a 115 kv and up. All contacts are of medium-pressu silver-to-silver line type.

Metal-enclosed Bus Run . . . *Isolate*

A new type of station bus-run design, for 15-k service, has each phase conductor completely isolate in its own metal enclosure, eliminating possibility phase-to-phase fault. The enclosures are dust- an weather-tight, so the bus runs may be used eithe indoors or outdoors.

UNIT EQUIPMENTS

Package Substations . . . *Accepte*

ONE of the first package substations (**Fig. 19**) wa installed during the year as the main substatio for a small New York State industrial plant. Duplica paths for the power were provided throughout, sinc certain chemical processes made reliability particular important. The substation equipment includes tw high-voltage circuit breakers, lightning arresters, fus protection for the transformers, two 1000-kva tran formers, and low-voltage switchgear. Single-ended un substations with a bus tie were used to permit futu addition of more low-voltage feeders and future expa sion of the substation by addition of more high-voltag gear, structure, and master unit substations.

The installation saved time and cut costs since, as package, there was only one set of specifications an one order. The equipment was received at the site large, preassembled pieces; detailed field assembly components was eliminated. The year saw installatio of several package substations, and more being pr duced. They incorporate all equipment between i coming high-voltage lines and outgoing feeder circui in a completely co-ordinated assembly.

Mobile Substations . . . *Interim Pow*

Typical of mobile unit substations produced durin the year was the streamlined, 3000-kva three-pha unit for the Southern California Edison Compan (**Fig. 20**). For two years it will be moved from cu tomer to customer to provide service while permanen facilities are being changed over from 50 to 60 cycle

The 10,000-kva 132-kv unit delivered to the Indiana olis Power and Light Company was the largest ev

uilt. The company had four major substations, each with a bank of three 10,000-va single-phase transformers, plus one for spare. During the war, three of these pares were used to establish a fifth substation, leaving four substations without a pare. Because the stations were connected elta-wye, failure of any one transformer ould put the whole station out of service. he one mobile unit substation replaces the ationary spare transformers, effecting a ibstantial saving.

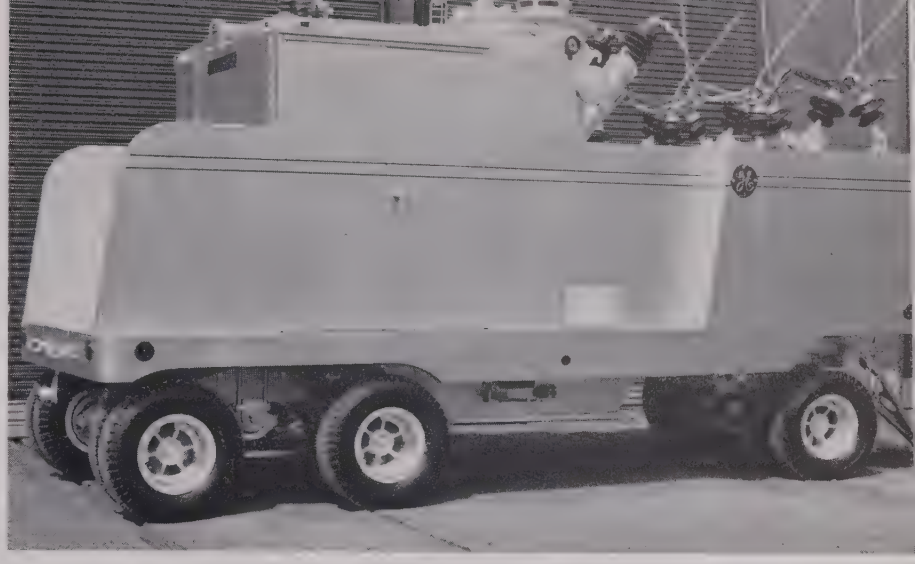


Fig. 20. Typical of mobile unit substations delivered during the year was this 3000-kva equipment for Southern California Edison Company

CAPACITORS

A NEW 25-kvar, pole-type, outdoor capacitor (**Fig. 21**), among the largest ngle capacitors manufactured commerally in this country, allows 225 kvar to e accommodated on one crossarm, compared to the rmer 180 kvar with smaller units. For a given var, fewer units are involved, less surface is exposed the weather, and fewer hangers, bushings, and conections are required. Weighing only 70 lb, a relatively mall weight increase over previous 15-kvar units, the apacitor may be used on the same standard hangers.

One of the features of the new capacitor is a castlass bushing with integral hardware, permitting a ermetic seal that is permanently moisturetight. The ushings are of exceptionally stable, low-expansion lass in which special nickel-steel alloy inserts are cast. metal mounting flange is fused directly to the glass, nd the flange in turn is welded and soldered to the apacitor case. The bushings are practically unaffected y weathering, micro-organisms, or thermal shock. Glass ushings were also applied to capacitors of lower ratings.

An important development in specialty capacitors as the application of silicone bushings and gaskets, ighly resistant to oils, alkalies, and acids. The silicone etains its elasticity over a wide range of temperatures nd will not shrink, pull away, or loosen. Among new pecialty capacitors were: a line of high-voltage units ith built-in radio-interference-suppression sections, r use with Slimline fluorescent lamp ballasts; a line r separate power-factor improvement of low powerctor ballasts; and small, lightweight, 400-volt, d-c apacitors for flash-tube applications.

CABLE

SUCH coverings as asphalted jute, asphalted duck tape, neoprene and synthetic-rubber jackets, and aped and cured polyvinylchloride jackets have been vailable as corrosion-resistant coverings for leadheath cables, both in ducts and for buried use. Neorene hose jackets and taped Flamenol jackets, the vo most recent additions to these types of coverings, creased in use during the year; they are more permaent because of resistance to oils and corrosive agents.

First of its type to be used in this country, a highressure, self-contained, gas-filled, 110,000-volt, isoted-neutral cable was being produced.

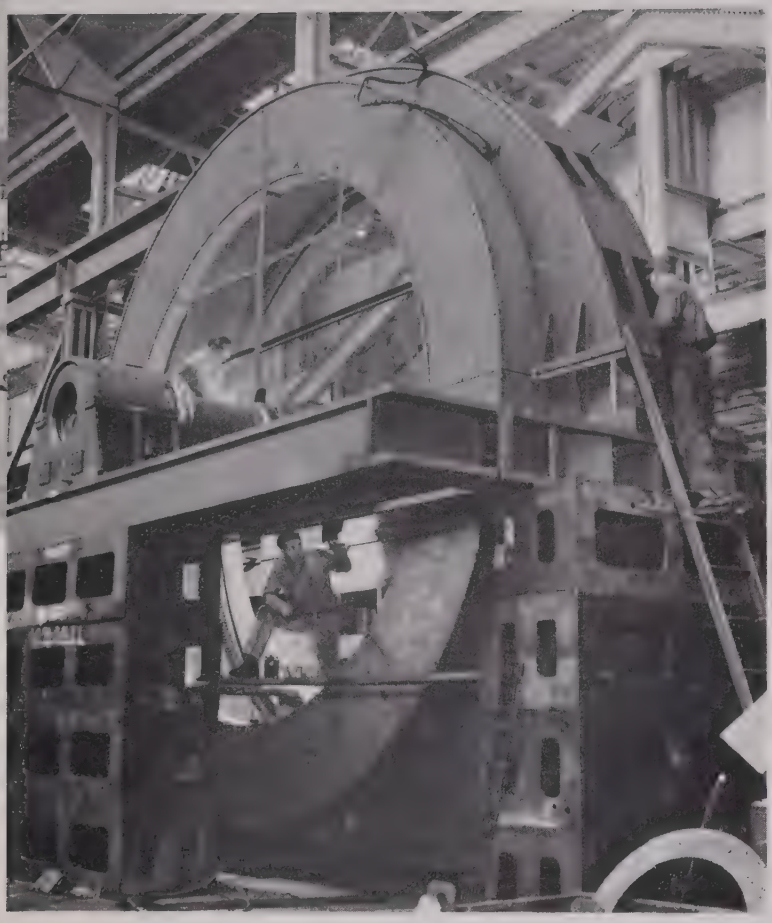
Butyl synthetic rubber insulation was applied to cable with a copper temperature rating of 80 C from 0 to 15,000 volts, the first rubber-like material available at such a temperature rating in that voltage classification. The material is extremely resistant to ozone. Suitable splicing tape and cement were also produced.

The outstanding electrical properties of polyethylene made it possible to produce a low-loss solid-dielectric insulated cable with a greater signal-transmission distance than other types of insulated cable. A new nonmetallic underground railway-signal cable with polyethylene insulation in Flamenol jacket replaced overhead wires.

A neoprene-covered weatherproof wire, for use instead of fibrous-covered wire in overhead distribution, has superior resistance to weathering, better moisture resistance, and more stable dielectric strength.

Silicone was used as an insulation for high-temperature 600-volt lead wire and ultimately will provide lead wires for temperatures from 300 to 350 F.

Fig. 21. Similar to the 15-kvar pole-type capacitor (*left*), this new 25-kvar unit permits the mounting of 225 kvar on one crossarm



Assembling a 110-ton synchronous motor, one of the largest ever built at Schenectady, to drive a roughing stand of a hot-strip mill. It is rated 4000 hp, 6600 volts, three-phase, 60 cycle, 78 rpm

INDUSTRIAL

EQUIPMENT, APPLICATIONS

• • • • • • • • •

MOTORS AND GENERATORS

Tri-Clad Motors . . . *Dial for Speed*

A NEW line of Tri-Clad brush-shifting adjustable-speed induction motors, in ratings from 3 to 50 hp and 220, 440, or 550 volts, features stepless speed adjustment over a 3:1 ratio by simply turning a dial. The entire unit (**Fig. 22**), with the exception of the starter control, is self-contained in a housing only a little larger than that for a constant-speed motor of comparable rating.

Remote speed control can be accomplished by use of a flexible-cable shaft, up to 10 ft away from the motor. For complete remote control, a small pilot motor can be used to drive the speed-control mechanism. For intermittent use, speeds below minimum rated speed may be obtained by adding secondary resistance. Plugging is possible by the same means.

Applications include driving textile machinery, draft fans, stokers, small paper machines, wire-drawing machines, laundry flat-work ironers, dough mixers, cement kilns, stamping presses, and pumps.

High-speed Induction Motors . . . *New Standard*

New standard types of construction were adopte in Type K open (dripproof) squirrel-cage inductio motors, for ratings of 800- through 1250 horsepowe Oil-ring lubrication is now used from 25 hp throug 900 hp, 3600 rpm; forced-feed oil lubrication wa formerly standard for the 800- and 900-hp size End-shield-type construction is now used from 25 h through 1250 hp, 3600 rpm. End-shield type bearin construction now is also available up through 2000 h 3600 rpm.

Synchronous Motors . . . *"Prepare to Submerge*

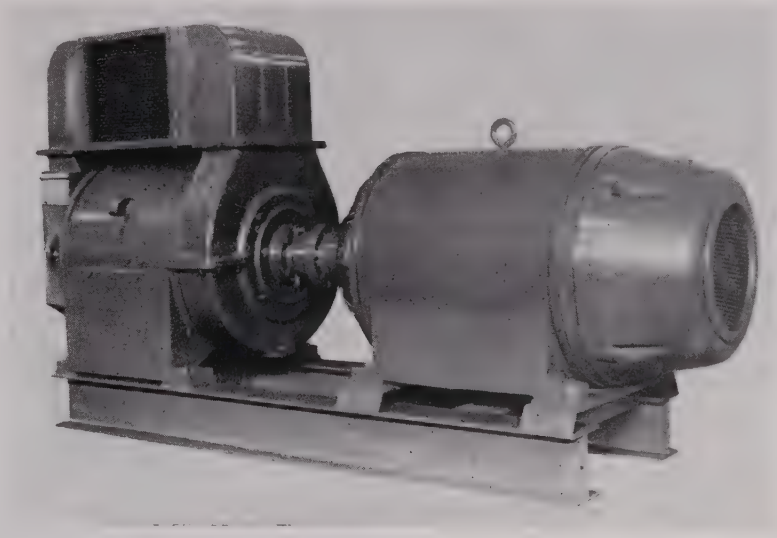
"Prepare to submerge" might be taken as an ord aboard a submarine, but in this case it's just getting river-edge mill ready for spring floods. Six water-tigh synchronous motors were delivered during the year t the Willamette River site of the Crown Zellerbac Company's paper mill at West Linn (Oregon). The were built to withstand submersion, since the riv may rise 40 feet during the spring thaws, covering th machinery and halting operations. Bearings an bearing pedestals are enclosed with the stator an rotor in a specially fabricated framework to prote them while sealed during flood periods. During imme sion, compressed air will be pumped through a flange pipe connection on top of each motor to force an seepage into drainage sumps. Each of the 2300-h motors normally drives three woodpulp grinders.

Four inert-gas-filled 300-hp 240-rpm synchronou motors, to operate in an atomosphere which may b inflammable, were designed with particularly smoot exterior surface. No bumpy terminal boxes mar th external lines. Only one access cover need be remove to have the field leads, stator leads, terminal board and bridge resistors for the relay all within easy reac

Fig. 22. Tri-Clad adjustable-speed induction motor, with pilot brush-shifting motor atop, which can be remotely dialed over a 3:1 speed ratio

otally Enclosed Motors . . . *Surface Coolers Below*

Seven large, totally enclosed, wound-rotor induction otors for driving boiler feed pumps through speed-creasing gears were built with an unusual arrangement f surface coolers combining simplicity and utility with ttractive appearance. The fabricated-steel stator frame f each motor is extended sufficiently below the stator aminations to permit the surface air cooler to be ounted directly under them, crosswise of the shaft, ithin the stator frame and above the sole plate.



g. 23. Two-unit, four-ball-aring motor-generator set nsisting of a totally enclosed unt d-c generator with air--air heat exchanger (*left*) and tally enclosed, fan-cooled in-ction motor

ractional-horsepower . . . *Standardization Helps*

Production of fractional-horsepower motors, used in terally thousands of industrial, farm, and home pplications, was boosted to an all-time high during the ear through a standardization program and increased anufacturing facilities. Even so, supply did not catch p with demand for certain types. Where formerly 5,000 kinds of fractional-hp motors were being pro-uced, the program reduced the quantity to less than 000.

pecial Equipments . . . *80,000 Rpm*

Among special motors for research purposes were hree rated 0.1 hp at 80,000 rpm, and only 1¾ in. in iameter and 6 in. long. The squirrel cage, on the out-ide, forms the rotor; the shaft and "rotor," carrying he primary three-phase winding, are stationary and orm the motor support. Also unusual were two 700-hp nd two 300-hp, 18,000-rpm motors. Four-pole, 600-ycle units, they have hollow stator conductors with irculating water for heat removal. The shells are also ater-cooled.

A line of totally enclosed unit-cooled generators was roduced for use in motor-generator sets (**Fig. 23**) or in ther generating applications in any nonhazardous tmosphere where the ratings make totally enclosed an-cooled construction impractical. Available in ratings from 30 to 150 kw, they are especially suitable for use in steel mills, cement mills, paper mills, and around large machine tools. Cooling is accomplished by an air-to-air surface cooler.

A new battery-charging equipment, meeting the standards of the Electric Industrial Truck Association, was a heavy-duty equipment tailored to fit the requirements of an 18-cell, 550-amp-hr lead-acid-type storage battery, operating at the tapered charge rate called for by the battery manufacturer. It consists of a single-circuit battery-charging motor-generator set with its control cabinet on a welded structural-steel framework over the m-g set. Connection of the battery to the terminals automatically starts up the m-g set.

Electronic Amplidyne . . . *Suicide Braking*

For those many types of motor control where precise regulation of current, voltage, and speed are essential, a new electronic amplidyne, consisting of a high-gain balanced d-c electronic amplifier and a motor amplidyne, was developed. Designed for use as a regulated adjustable-voltage power supply for d-c motors up to 1½ hp and as a regulated exciter for larger adjustable-voltage drives up to 200 hp, the new equipment (**Fig. 24**) has an output of 1½ kw, 250 volts, operating on either a 220- or 440-volt, 3-phase, 60-cycle power supply.

With a speed range of 20:1 or greater, it maintains speed closely at any setting, regardless of load conditions. It gives smooth, rapid acceleration and, by means of current limit control of acceleration and stalled current, reduces starting shock. Suicide braking, utilizing

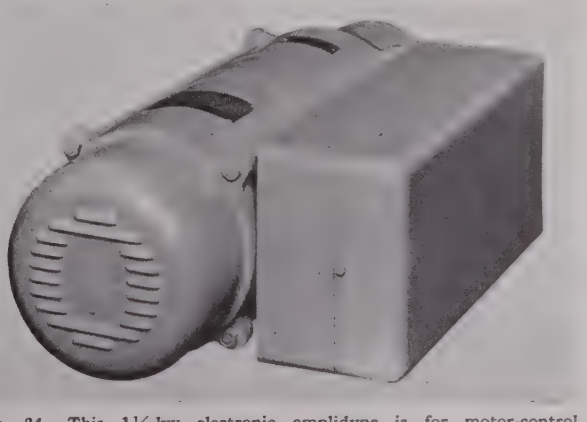


Fig. 24. This 1½-kw electronic amplidyne is for motor-control applications where current, voltage, and speed must be regulated precisely

Fig. 25. Controllers with draw-out air circuit breakers can be lined up with Cabinetrol or unit substation equipment, so a neat, convenient, and complete electric installation can be made

current limited regeneration, provides safe, quick stopping without undue stress to motor or driven load.

CONTROL

Industrial Control . . . *With Breaker*

A NEW line of controllers for low-voltage (600 and below) a-c or d-c motors is unique in that they include in one self-standing steel enclosure not only the equipment to start, stop, and control a motor, but also a draw-out air circuit breaker which provides adequate short-circuit protection (25,000 or 50,000 amp). Because of its draw-out feature, the breaker (**Fig. 25**) not only provides circuit protection but also serves as a short-circuit isolating device.

New motor-control centers, to supplement established Cabinetrol lines, are floor-mounted cabinets in which the motor control for all machines in a given area, or in a particular process, have been grouped together. They are readily bolted together in sections to which other sections can be added at any time.

A line of high-voltage control was designed specifically to suit the needs recognized by the National Electric Code of electric equipment in the vicinity of pipes, tanks, or processes which contain hazardous gases, liquids, or other materials. The new control has standard self-standing enclosures, but all normally arcing contacts are enclosed in individual explosion-proof-type housings or immersed in oil.

Appliance and Aircraft . . . *Welded Laminations*

Small size, low cost, and versatile circuit and mounting arrangements were particularly considered in new designs of multicontact a-c relays and solenoids for appliances and vending machines (**Fig. 26**). The solenoids have welded rather than riveted laminations, the welds being on the edge of the frame outside the main magnetic path so that eddy current losses are reduced and efficiency consequently increased.

For use in circuits where long-life switching is required with a small amount of power, such as in communication and electronic applications, a telephone type relay was constructed with stainless steel and monel metal bearings, palladium contacts, and molded insulating parts.

An aircraft load center, consisting of a draw-out panel containing all the regulating and switching equipment, was introduced, with the new large commercial and military aircraft in mind.

Electronic Control . . . *Three-way Contour*

For use on machine tools, a contouring control follows a three-dimensional pattern and directs the machine to make an accurate duplicate without constant supervision by the operator. It makes possible the automatic production of many different kinds of metal shapes, such as dies, that previously could be made only by hand.

Register controls were applied to high-speed newspaper presses for color reproduction. Better-looking jobs are produced, and out-of-register rejects are cut down greatly.

An electronic equipment designed for remote positioning of valves, gates, dampers, etc. in industrial plants is a simple unit that will meet the requirements without use of complicated circuits.

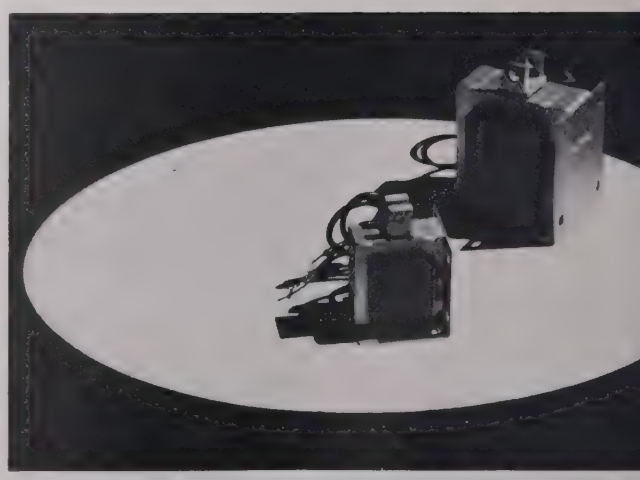


Fig. 26. For appliances and vending machines there are new, versatile relays and solenoids

A modulated-light photoelectric relay was produced for use over distances as great as 1000 ft without being affected by changes in illumination. It is relatively free from interference by smoke, moisture, etc.

An electronic motor-control system using half-wave rectification was added to the Thy-mo-trol line. It gives the user of fractional-hp motors the important feature of stepless speed control, close speed regulation, and controlled torque.

Regulators . . . *Package*

Three new packaged regulating components were made available to industry. The first is a magnetic vol

e regulator and exciter for high-frequency induction-ating generators and features absence of moving rts. The second is an amplidyne control for a two-age amplidyne regulator; it can be used for a current, ltage, or frequency control. The third is the draw-out ctronic preamplifier (**Fig. 27**), incorporating a mag-tron feed-back unit, electronic power supply, and ctronic amplifier. It is so constructed that it may be itched out when maintenance of any of the three its is required, and the drive continues with reduced curacy.

Fig. 27. An electronic preamplifier of draw-out type. *Left*, magnetron; *center*, power supply; *right*, amplifier

INDUSTRIAL HEATING

rnace Brazing . . . *Sealed Evaporators*

A LARGE roller-hearth copper-brazing furnace, for brazing plate-type evaporators for industrial re-geration, joins and seals two steel sheets in sizes up to ½ ft wide and 12 ft long. One sheet is flat, and the her embossed to form channels for passage of the olant between the plates.

The furnace, about 185 ft long, is rated 630 kw, with 5 kw for each of the preheat and high-heat chambers. water-jacketed cooling chamber completes the fur-ce. The preheat and brazing chambers each holds one rge assembly, charged intermittently.

ight Annealing . . . *Space Saver*

A large continuous furnace for annealing bright steel rip was installed for annealing and coating strip in dths up to 54 in., at a rate of 20,000 lb per hr. High-equency power is used for heating the strip by induc-on, in the main section, in line with a conventional ller-hearth furnace for equalizing and holding temper-ure. Two 700-kw 9600-cycle motor-generator sets, erating in parallel, supply the power to the induction ils. The equipment, used with heavy-gage strip, is arranged horizontally to avoid bending the strip around rolls or drums in its travel through the furnace. The high concentration of power input to the strip by induction requires only a short length of induction coil, thus saving substantially in floor space and building length as compared to a conventional furnace of equal capacity. Also, fewer rolls are required in the furnace to support the strip. Two similar furnaces, for lighter-gage strip up to 48 in. wide, were under construction.

All these furnaces have an extended cooling chamber to regulate cooling of the strip and are designed for use of a protective atmosphere. The strip passes directly from the cooling chamber to the coating bath.

Induction Heating . . . *Surface Hardening*

Typical of product improvement obtained with induction heating was use of surface-hardening to increase machine-tool life of lathe bedways, adopted by two leading machine-tool manufacturers; its use by farm-equipment manufacturers to produce longer-life blades for mowing machines; and its use by automotive manufacturers to reduce wear on such important parts as valves (**Fig. 28**), pins, shafts, cams, etc.

A calculating-machine manufacturer who had installed an induction heater for experimental use quickly put three equipments into production use when it was found that heat-treating operation costs could be cut to between 12 and 50 per cent through elimination of grinding or straightening operations necessary with older heat-treating methods.

Ten 20-kw electronic induction-heating equipments went into service in the production lines of one large washing-machine plant, for various heat-treating, brazing, and soldering operations.

An important development was the application of 9600-cycle motor-generator-type equipment in induction heating of electrolytic tin plate for flow brightening.

Use of this 20-kw electronic heater for induction-hardening of hatchet heads doubles production at a fraction of previous cost

Dielectric Heating . . . *Higher Frequency*

Investigation continued in the field for application of higher-frequency magnetron-tube equipment, making available for operation a frequency of 915 megacycles.

In the frequency range of 3 to 40 megacycles there was steady growth, as operating experience with pilot production units in many plants demonstrated where quality improvement or cost reduction can be obtained through use of dielectric heating.

WELDING

Arc Welding . . . *Smaller, Lighter*

A 50 PER CENT saving in over-all size and weight was effected in a new line of heavy-duty single-operator d-c arc-welding machines (**Fig. 29**). Operating at 3500 rpm, the new welders have 200-, 300-, and 400-amp NEMA ratings. The arc is easily established and maintained, since more than full arc voltage is generated instantly after short circuit. The operator may preset the correct current for any given job without having to make other adjustments after the arc is struck.

A new 220/440-volt a-c inert-arc welder (**Fig. 30**) has the welding transformer, control panel, capacitors for power-factor improvement, bank of series capacitors to stabilize the arc, high-frequency pilot circuit for arc starting, and water and gas solenoid valves all built into a single compact unit, enclosed in a sturdy dripproof case, and with electrical terminals and gas and water connections brought out to convenient outlets. Specifically for use with the inert-gas welding process, the equipment is particularly suited for welding aluminum,

Fig. 28. Use of induction heating means that heat is applied only to the tip end of automotive valves. Inset, a closeup of rotary fixture for holding the valves

Fig. 29. This heavy-duty single-operator d-c arc welder has the station welding generator, driving motor, generator control and panel, and mo starter all assembled into a single compact unit

magnesium, and beryllium copper in an atmosphere argon gas without use of flux. Suitable for both manu and machine operation, it may also be used to weld wide range of other metals and alloys.

A new electrode for hard-surfacing applications w introduced for use where resistance to impact, wea and abrasion is required. It will work to over 50 Roc well C, with either a-c or d-c reverse polarity.

Resistance Welding . . . *Kva-demand Reduc*

Investigations have indicated that standard lo voltage nonsynchronous controls can be used sat factorily with capacitors for power-factor improveme at materially lower voltages than was previously co sidered feasible. By providing an autotransformer ahea of the equipment, it is possible in many cases to use t existing welder and control and to improve the pow factor with series capacitors. In addition, the kv demand is reduced and the possibility of light flick materially lessened.

The NEMA N2 combination nonsynchronous co trol, used extensively by the automotive industry, w redesigned. Another new development was the NEM S4H synchronous precision control, which meets th new NEMA specifications. It provides precise contr of weld time, cool time, and the number of impulses. also incorporates a sequence timer to provide adjus ment of squeeze, hold, and off time. It can be mount separately or on the right-hand side of the welder.

To meet the requirements of a new technique aircraft-propeller manufacture, calling for stamping o two halves of each blade and then seam-welding the together, an amplidyne positioning control was d veloped with a contour system such that the edge of t propeller is always correctly positioned with respect the welding head. The equipment provides two-dime sional control and makes use of amplidynes, magne pick-ups, and vacuum-tube amplifiers in its operatic

VEHICULAR TUNNELS

BROOKLYN Battery Tunnel, now under construction, will consist of two two-lane tubes, each slightly ver 9,000 ft long, making it one of the longest vehicular nnels in the world. In it will be 51 large multispeed ns for ventilation, most with three speeds and a few ith two. Transformers, power-distribution switchgear, ntrol switchboards, control panels, and miscellaneous cessories will be required, not alone for the fans but lso to supply power for the many pumps to remove in water and seepage.

A central control board will provide means of selecting the speed of any fan and will indicate the speed. ignal lights and code-flashing equipment will indicate ntinuity of traffic flow or any interruption, such as re or accident. The signal lights will indicate when fire equipment or emergency trucks respond to an alarm and when conditions are again normal. Recording meters will show concentration of carbon monoxide in the various tunnel sections. Control of the entire tunnel will be centralized in one control board. One man can keep the entire tunnel in operation.

Fig. 30. This new a-c inert-arc welder may be mounted on a three-wheel running gear for portability. An easily removed back panel gives access for inspection and maintenance

MINING

Dredges . . . *Two of Largest*

SCHEDULED to begin operations in the Netherlands East Indies late in the year were two of the largest tin-mining placer dredges ever built, the 4150-ton 476-ft *Stuyvesant* and its sister dredge, the *Roosevelt* (**Fig. 31**). Diesel-driven generating equipment and variable-voltage shovel-type equipment for all important main drives are among their electrical features.

The identical dredges will operate off island coasts in the ocean, excavating tin-bearing sand and gravel to a maximum depth of 100 ft below water level, with an estimated output of 300,000 to 400,000 cu yd per month. Hulls are 246 ft long, 76 ft wide, and 12 ft 9 in. deep, with a total length, over the gangway bridge at the bow and the tailing sluices at the stern, of 476 ft. Pilot houses are 36 ft above deck, and the highest point of the dredges 85 ft above water line—approximately the height of a nine-story building.

The all-welded hull is divided into 52 compartments by two longitudinal watertight bulkheads and 12 main transverse watertight bulkheads, the ladder well, and miscellaneous tank bulkheads. The digging ladder is 216 ft long, 8 ft wide, and 13 ft deep; without equipment it weighs 220 tons, and with equipment 650 tons. It carries an endless chain of 148 manganese steel buckets, each weighing 4,025 lb, with a capacity of 14 cu ft.

Each dredge has a total power equivalent of all electric equipment of approximately 7500 hp. There are three diesel-electric generating sets, the third being a spare or standby unit. Each 875-hp, 375-rpm diesel engine is connected to a 600-kw, three-phase, 50-cycle, 400-volt, 0.70-power-factor generator supplying power

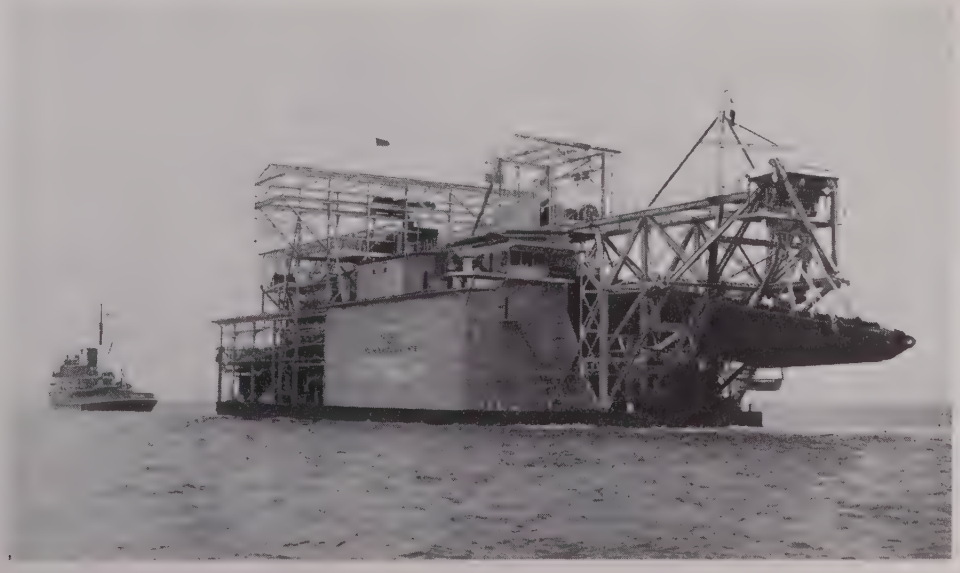


Fig. 31. One of the largest tin-mining placer dredges ever built, the *Roosevelt;* for service in the Netherlands East Indies

to the electric motors. The equipment includes devices for indicating and recording the performance of all major units.

Cable Skids . . . *Quick Disconnect*

A considerable number of cable skids, special for open-pit mining service and used at the point where the trailing cable to the excavating machine taps onto the main 2300- or 4000-volt distribution line, went into service during the year. The skid has a number of sockets such that the trailing cable, fitted with suitable plugs at the ends, can be quickly connected or disconnected from the cable skid. Devices in the skid provide overload protection for the cable and the excavating machine, and a special arrangement of current transformers provides for disconnecting the circuit in case of ground fault.

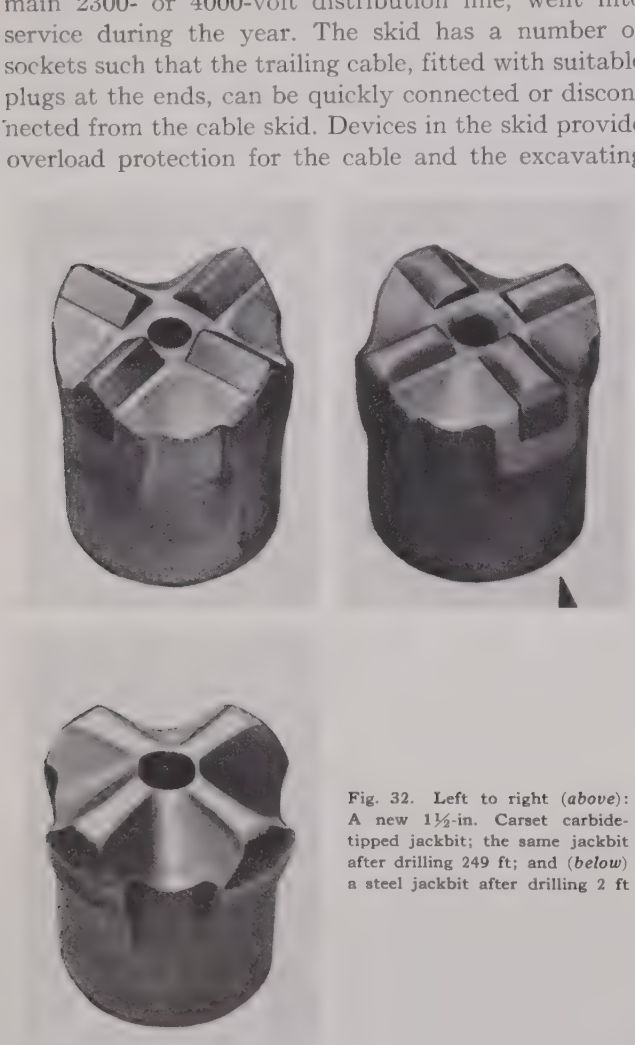


Fig. 32. Left to right (*above*): A new 1½-in. Carset carbide-tipped jackbit; the same jackbit after drilling 249 ft; and (*below*) a steel jackbit after drilling 2 ft

Mine Hoists . . . *New Primary Unit*

A new high-voltage primary unit for wound-rotor motors used for driving mine hoists combines in one steel enclosure the manually operated oil circuit breaker, the high-voltage air-break primary reversing contactors, the line disconnecting switches, and the current transformers. Completely wired and assembled in the factory, the unit is ready for quick and convenient installation in the mine-hoist house.

Jackbit . . . *Carbide Tipped*

A co-operative development program set up by the Ingersoll-Rand Company and the Carboloy Company of Detroit, a G-E affiliate, resulted in the production of a carbide-tipped jackbit that increases drilling speed and reduces cost of drilling. The 1½-in. diameter jackbit (**Fig. 32**), the widest used throughout the world, was the first produced. In one comparison, just one of the new Carset bits, consuming 11,040 cu ft of air, completed a job in 46 minutes. Using steel bits, 4 of four sizes were required, air consumption was 20,64 cu ft, and drilling time was 86 minutes.

IRON AND STEEL

THE steel industry continued to emphasize the need for more automatic equipment, higher speeds, and a greater output per mill or processing line to combat rising costs and to compete in today's markets. As always, the electrical industry played a major role in this effort.

Hot-strip Mills . . . *Heat Retaine*

A new 66-in. reversing hot-strip mill, for the Pittsburgh area, will be the first completely new installation of its type; two reversing hot-strip mills now in operation were reconverted for such service. The reversing hot-strip mill is an economical tool for the production of hot strip in small quantities.

A 48-in. semicontinuous mill, which went into production in the Youngstown area, has an existing rougher supplemented by two 2500-hp and one 2000-h finishing stands.

One of the largest a-c mill motors ever built by the General Electric Company will go into operation soo to drive an intermediate roughing stand on an existing semicontinuous mill.

An existing 76-in. hot-strip mill is being equipped with two modern coilers. These coilers, together with the accompanying approach tables, pinch rolls, etc will be driven by MD motors with amplidyne adjustable-voltage control.

Cold-strip Mills . . . *Amplidynes at Wo*

The first tandem mill with individual generators for each stand motor, one of the world's largest and fastest five-stand tinplate mills, went into operation. Stand has twin double-armature driving motors (**Fig. 33**).

A 54-in. four-stand sheet mill for installation in the Chicago area will use individual generators for the main-stand motors as well as for the uncoiler and winding reel. Power is supplied by one 6000-kw synchronous motor-generator set and one 6400-kw synchronous motor-generator set, with amplidyne control of power factor.

A 93-in. three-stand mill, going into production soon is supplied with power by an unusually large synchronous set consisting of three 3500-kw main generators one 700-kw reel generator, and one 14,000-hp synchronous driving motor. An existing 42-in. five-stand mi will be speeded up and the power increased by the substitution of a new 2000-hp, 500/900-rpm motor for the existing 1250-hp, 350/790-rpm motor on Stand

93-in. three-stand mill, originally built with one 1500-) motor driving each stand, will have an additional 00 hp added to Stands 2 and 3. A four-stand tandem ill for rolling both silicon steel and stainless steel (**Fig.** :) went into operation during the year.

A new two-stand temper pass mill with twin driving otors (**Fig. 35**) on the main stands and delivery iller is now in operation. A regulating tensiometer itomatically controls the strip tension between Stands and 2. Amplidyne adjustable-voltage control and mplidyne control of tension are provided.

ocessing Lines . . . *For Product Finish*

Processing lines continued to represent a major por-)n of the modernization and expansion program in the eet- and strip-finishing industry. It is interesting to)te that adjustable-voltage control is now being used most exclusively for strip-processing lines.

Several pull-through pickling lines are being fur-shed with electronic control of the winding reel which ropels the strip through the pickling tanks at a)nstant preset strip speed. An existing electrolytic eaning line is being completely revamped and speeded) to a maximum speed of 2500 fpm.

A 54-in. side-trimming line was designed to handle),000-lb coils (24 to 72 in. diam.) at speeds of 500 to 500 fpm. The control will either automatically hold ops before and after the trimmer, or run the strip raight through under tension control.

A 54-in. sheet-shearing line will handle 50,000-lb 24/72-in. diam.) coils at a strip speed of 200/800 fpm. hoto-thyratron loop control operating in conjunction ith adjustable-voltage control is being supplied.

A 60-in. sheet-shearing line is being modernized and)eeded up by the substitution of adjustable-voltage)ntrol in place of the original magnetic control.

A unique feature of two galvanizing lines is that a ew type of d-c motor will be used to cover the wide)eed range required. These motors are a modification the "unit-cooled" motor and are so arranged that one n circulates air through the air-to-air heat exchanger hile another fan circulates air through the motor itself. ne small a-c motor drives both fans, and the ventila-on is not impaired by low-speed operation.

looming, Slabbing, and Breakdown Mills

A new 40-in. reversing blooming and slabbing mill ill have a 6000-hp 40/100-rpm main drive and a 250-kw flywheel motor-generator set.

A new 32-in. reversing blooming mill in South merica will be driven by a 3500-hp 50/120-rpm d-c iotor and a 3000-kw flywheel motor-generator set. mplidyne adjustable-voltage control will be supplied.

A new edger drive rated 1500-hp 150/360 rpm will e added to an existing reversing blooming and slab-ing mill. A 1250-kw synchronous motor-generator set ill be used with amplidyne control. This mill will roll abs for the reversing hot-strip mill mentioned pre-iously.

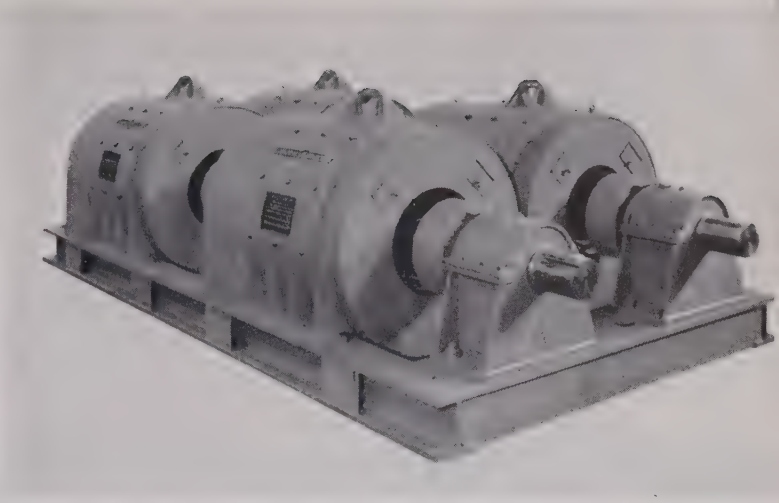


Fig. 33. Twin 4000-hp double-armature motors for fifth (last) stand of one of the world's largest and fastest tinplate mills

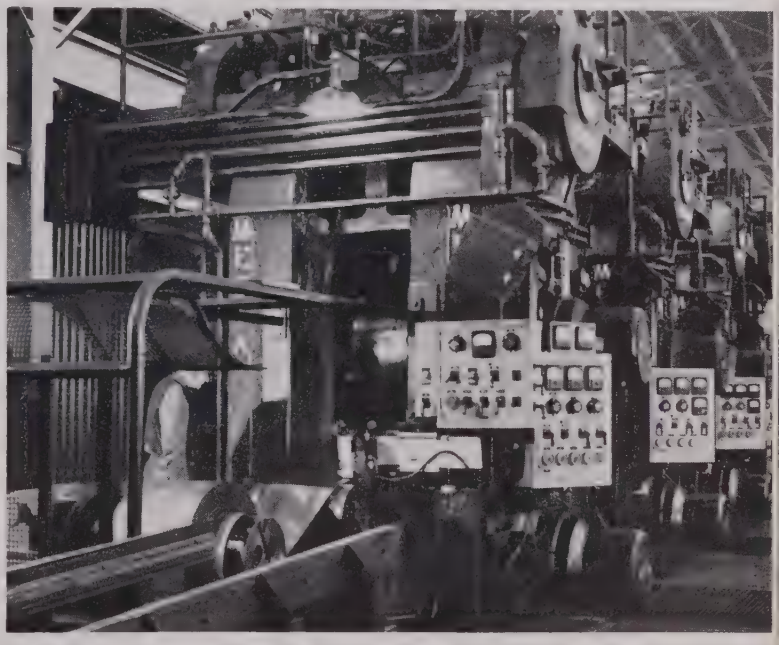


Fig. 34. Operating side of four-stand tandem mill for rolling silicon steel and stainless steels

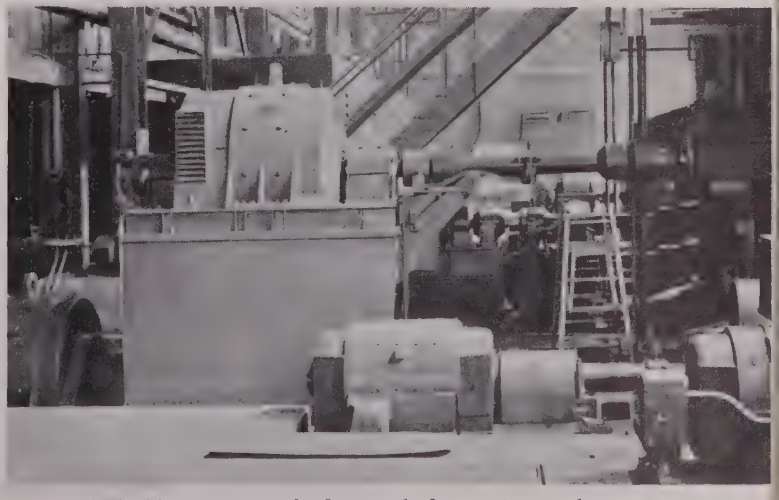


Fig. 35. Twin-drive motors on the first stand of a new two-stand temper pass mill; entry puller drag generator in foreground

Other Mills . . . *Krämer Drive*

A mid-western steel plant decided to power the roughing train of its existing four-strand rod mill with a new 1750-hp 900/560-rpm Krämer drive. Study indicated that the Krämer drive would provide the small increments of speed adjustment so desirable for maintaining a loop between intermediate and finishing trains.

A new 10-in. bar mill was equipped with an electrically operated billet shear. This shear is driven by MD motors and its success is made possible by the use of the amplidyne exciter.

Two new seamless-tube mills are equipped with motors having very special transient speed characteristics. Amplidyne voltage-and-speed regulators are used with electronic control for extreme accuracy.

A 26-in. billet mill was equipped for drive by a 2500-hp synchronous motor. This same motor will be used to drive a motor-generator set used to supply power to a new continuous mill which will eventually replace the present 26-in. mill.

Drawbenches . . . *Reversing Chain*

Activity in the cold-drawing of metal continued at a high level. The main activity has centered around the reversing-chain and rack-type drawbenches. All of these benches use adjustable-voltage control, and this type of control is gaining in popularity for the conventional-type benches. The reversing-chain drawbench is designed to eliminate the carriage-return drive.

Controls and Gages . . . *Thickness Gage*

An x-ray thickness gage developed in the Company's General Engineering and Consulting Laboratory was successfully applied for measurement of steel thickness in a hot-strip rolling mill. It measures the thickness to within 2 per cent while the steel is being rolled.

A magnetic side-register control, operating on changes of inductance caused by variations of the steel strip position, was developed to solve the problem of accurately guiding a fast-moving steel strip.

As part of the variable-voltage control system for mills and processing lines where speed, current, or voltage regulation are required, an amplidyne packaged control unit was developed. It is used to control tension on a winding reel of a cold-strip mill.

CEMENT PLANTS

COMPLETE replacement of two 40-year-old plants was carried out during the year by a large western cement company to incorporate the most modern equipment. Two 7500/10,000-kva package-unit substations, metal-clad 4160-volt indoor switchgear, 12 load-center unit substations with Pyranol-filled transformers ranging from 300 to 1000 kva, and eight 4160-volt pulverizer motors of ratings ranging from 500 to 1000 hp were employed.

LUMBER AND PAPER

DESIGNED to detect magnetic metallic objects of $\frac{5}{8}$-in. diameter, or larger, embedded in a log, a new electronic detector will be used at Fort Lewis (Wash.), to salvage more than 12,000,000 feet of lumber in which are embedded metal fragments and an undetermined number of unexploded artillery shells. This metal detector utilizes a coil with a 60-in.-diameter opening through which the logs will be floated. Metallic objects embedded in the logs passing through the coil system create a voltage unbalance because of changes in the magnetic field. An electronic circuit, measuring the voltage unbalance produced by the field, actuates visual and audible alarms. Any log found to contain metal can thus be identified and diverted before reaching the sawmill. Operating continuously at a rate of 10 to 4 fpm, the device can scan nearly 20,000 linear feet of timber a day.

Modernization and expansion of the paper industry was reflected by the number of large grinder motors being manufactured. For Southland Paper Company there were four 4000-hp, 200-rpm, 6900-volt, 1.0-power-factor motors; for Bowater Pulp & Paper Company, Newfoundland, four 5000-hp, 231-rpm, 4600-volt, 0.8 power-factor motors; and for St. Croix Paper Company in Maine, a 4000-hp, 250-rpm, 25-cycle, grinder motors

PRINTING AND TEXTILE

Web Register Control . . . *Better Magazine*

PHOTOELECTRIC side register and cut-off register controls were applied to new presses turning out magazines at unusually high paper speeds, giving an accuracy of $\pm\frac{1}{32}$ in. in locating the printing on the continuous sheet and also in slitting and cutting off the sheet. An electronic amplidyne equipment automatically positions the feed roll to lead the paper web into the first printer with correct sidewise relationship. Five more straight-electronic side-register panels feed correcting motors directly through thyratrons to hold lateral web alignment at other points in the press. Another control, of the electronic cut-off type, properly positions the cut across the paper after it has been printed and is being divided into magazine sections. An eighth similar control longitudinally relates the printing on the back side to that on the front.

Winder Drive . . . *Single Sign*

The first Thy-mo-trol winder drive of its type installed in a plant of the Sealright Corporation at Fulton (N. Y.), is capable of winding, at constant tension, the output of a printing and coating machine operating at up to 500 fpm web speed and 300 lb total tension. The ratio of roll build-up is 6:1. A novel feature is that both armature and field of the Thy-mo-trol winder drive motor are controlled from a single signal—a movable-core reactor operating from a dancer roll.

Turbine Control . . . *By Push Button*

The electric governor control previously employed in the paper-machine-drive field was introduced to the textile industry for use with the range-drive turbine. The textile-machine operator is thus given push-button control over the turbine, located some distance away

The turbine has a speed range of 20:1, or higher, and equipped with two preset speeds, one to hold a low ed for inspecting the cloth and the other to hold a h running speed. In addition, the unit is equipped h push-button control for jogging and braking. ecial provision is made to provide high steam flow ring startup, when the inertia load of the driven chine is very heavy.

o-for-one Twister . . . *Possible with Alnico*

For some 60 years, according to the records, textile n have been thinking about the two-for-one principle twisting. Machines now in universal use give one rn per spindle revolution; the two-for-one would give o turns of twist for each revolution, with just one vantage: the doubling of production.

Saco-Lowell Shops of Biddleford (Maine) announced ring the year that a two-for-one yarn twister had en successfully developed, following a program of veral years in which G-E engineers worked closely th engineers of the machinery builder. Ingenious use Alnico magnets to hold stationary a platform surunded by an air gap made the new twister a reality. y use of individual motors for the spindles and of a ecially tailored adjustable-frequency power supply, gh speed of operation and high degree of uniformity the twisted product were achieved.

ylon Spinning . . . *Gears Replaced*

More than 1800 fractional-horsepower motors were plied by one manufacturer to the elements of nylonarn spinning frames, displacing gears and line shafts. he possibility of costly shutdowns resulting from ilure of any one of several thousand gears, bearing uplings, or shafts is practically eliminated, and the dividually motorized elements of the frame lead to nsiderable space saving.

The installation involves eight complete 112-yarn inning frames. The equipment includes six complete adjustable-frequency power supply equipments, with motor-generator sets, amplidynes, electronic preamplifiers, magnetic control, eight 50-hp d-c motors and the 1800 fractional.

RUBBER AND PLASTICS

THERE was a definite trend to the use of completely electrified calender trains (**Fig. 36**) for processing rubber fabrics. Individual electric-motor drives were advantageously used in a large number of installations to supersede the mechanical drives formerly used to drive various auxiliary units in complete calendering units.

. 36. Electrically co-ordinated rubber calender train used for processing cotton and rayon tire fabric, at the Dayton Rubber Company. (*Artist's perspective*)

Fabric-solutioning or dipping units, with individual electric drives operating in tandem with the calender trains were incorporated in several co-ordinated calender trains. Continuous, rather than batch, processing of rubberized fabric is thus achieved.

The use of drawout air circuit breakers in the low-voltage-control field and the use of air-break contactors with current-limiting fuses in the high-voltage-control field were extended. The year also saw the use of more totally enclosed motors in the larger rubber mills.

The relatively new field of calendering of polyvinyl chloride sheeting and film was benefited by the development of electronically controlled calender drives. The electronic speed regulator on the calender itself is important in maintaining a constant gage of calendered film. Wide latitudes were provided in modes of operation of the auxiliary drives, to give the operating flexibility needed in the development of the calendering processes. Several 400-hp calender drives were being built with a rated top speed of 100 yd per min.

FOOD INDUSTRIES

THE prosaic cookie has finally come under the spell of the electron. Adjustable-voltage d-c drives, as well as electronic control, now speed the cookie on its

way through 1200-ft cookie machines, from cutters and molders through the ovens to coolers, stackers, and packing tables. Accurate speed control between various drive units assures uniform, well-made cookies of all types, at maximum production speed.

Co-ordinated electric drive has simplified installation, improved uniformity, increased production, and decreased maintenance when compared with previous mechanical speed changers.

WATER SUPPLY

TO THE northwest of Denver (Colo.), in Rocky Mountain National Park, the Colorado River is born on the western slope of the Continental Divide. It flows to the west and south to the Pacific. A relatively few miles away the Big Thompson River is also born. Being to the east of the Continental Divide its flow is much less, and its course is across land that is often parched.

Now there has been completed a 13-mi tunnel piercing the solid granite of the Great Divide at slightly above 8000 ft elevation, and under Summit with its 12,000-ft elevation. With a diameter of 9½ ft, and with its eastern exit 107 ft lower than its western entrance, the Alva B. Adams Tunnel diverts Colorado River water to the Big Thompson and Poudre Rivers and a system of Canals in eastern Colorado. An increased yield of $20,000,000 annually in farm crops is expected, and 175,000 kw will be generated upon completion of the project.

The Colorado-Big Thompson Project of the U. S. Bureau of Reclamation impounds water of the Colorado River system in the Granby Reservoir. Pumps there raise the water to nearby Shadow Mountain Reservoir, at a varying lift of 89 to 183 ft, according to storage conditions. From there the water flows by gravity to Grand Lake and into Adams Tunnel. Green Mountain Reservoir, on the Blue River, insures water for the western flow when water diversion at Granby Reservoir would leave insufficient water for the western stream.

Upon leaving the Adams Tunnel the water passes through a number of storage lakes and power plants before it reaches the 5500-ft level and becomes of interest for irrigation.

Three large synchronous motors of unusual design were required for the Granby pumping plant, to drive the vertical centrifugal pumps. The motors, rated 6000 hp, 327 rpm, 6600 volts, will be 76 ft below the surface of the ground, inside a pumping station that is 176 ft high, of which all but 50 ft will be below ground level. The station will be an oval-shaped concrete structure. The unusual construction of the station requires specially designed motors having enclosed cooling systems complete with air ducts and surface coolers. A metal housing will enclose all three motors. Electrically operated openings will be provided in the housing to allow heated air to be exhausted into the motor room for heating the building.

FARM INDUSTRY

Battery Chargers . . . *Overni*

TWO new lightweight battery chargers, of the sele nium-rectifier type, may be used without removin the discharged battery from the vehicle during th charging operation. The one designated for farm us (**Fig. 37**) will charge the average truck, car, or tracto battery in 12 hr or less. The larger of the two units 7¼ in. in its maximum dimension and weighs only te pounds. The other unit, which is smaller, will do th job within 24 hr.

Fig. 37. The battery of this tractor will be charged overnight by the sm selenium-rectifier charger standing on the hood and connected into a conve ience outlet

Rural Power Systems . . . *Fast Load Growt*

Ten or 12 years ago rural power-distribution system were designed to carry initial loads averaging about 10 kw-hr per month per consumer, with the expectatio that consumption would reach 200 kw-hr in about 1 years. Actually, however, consumption reached 20 kw-hr per month in considerably less time; preser facilities are badly overloaded, and load is ex pected to increase to between 300 and 500 kw-hr pe consumer.

The initial systems, laid out with one substation o 100 to 300 kva, and one or more 7200/12,470-vol grounded-Y, radial feeders varying from 15 or 20 to 8 or 100 mi from the substation, became inadequate fo present and expected loads because of high losses in th long overloaded feeders, excessive voltage drop, an poor continuity.

An analysis to determine the most economical typ of system, with reference to size of substation an maximum kva per feeder, has shown the 7200/12,47 volt distribution lines to account for the bulk of th investment. Considering the costs of the various item making up the system, the analysis indicated that sub stations of 1000 to 1500 kva produce the lowest over-a cost compared to other sizes, assuming no subtran mission has to be built.

nway Park, Boston, now matches the Yankee Stadium as the best-hted baseball park.

LIGHTING

QUIPMENT AND APPLICATIONS

MORE light per foot was obtained for Slimline lamps by increasing their current ratings. With previous current range of 100 to 200 milliamp, these ng, thin fluorescent lamps had their operating range tended to 300 milliamp, with no change in rated lamp fe. Operation at the higher current ratings is particularly applicable for industrial and commercial lighting fixtures and in show cases, wall cases, show-window ghting, or wherever high light output per foot of lamp paramount. Ballasts designed for the higher rating re required if more current is used.

rojector Lamps . . . *Compact*

Use of a side-prong base in new 150-watt projector ot and projector flood lamps (**Fig. 38**) reduces lamp-d-socket over-all length approximately two inches, rmitting a like saving on over-all fixture thickness. he lamps were developed to meet a growing demand r lighting equipment combining fluorescent and fila-ent lighting, particularly in store lighting; streamline sign had been difficult because of the over-all fixture ickness required by the projector lamp. The side-prong se fits heat-resistant separable connectors.

emisilvered . . . *Smaller*

To meet the demand for varied store-lighting applications, a 200-watt medium-screw-base semisilvered wl lamp was introduced to supplement the 300-nd 500-watt mogul-base units. A circular inside-osted "window" at the end of the bulb provides down-ghting. When installed in luminaires which provide least a 20-deg shielding angle tangent to the bulb, ne lamp can be advantageously employed above dis-lay tables in stores and above the customers' side of ass-top counter cases.

Airplane Lighting . . . *Peace Version*

A new, small, light-weight, reflectorized airplane reading lamp—a peacetime version of the wartime gun-sight lamp—has been introduced in the Boeing Stratocruiser, postwar "Big Brother" of the B-29 Superfortress. For practically the same wattage as lamps previously used as aircraft reading lamps, this 28-volt 20-watt lamp (**Fig. 39**) provides almost 10 times the illumination over the reading area. Most of the light is confined to a 20-in.-diam area at three feet. Recessed into the ceiling or above the window, the lighted lamp avoids glare in the eyes of other passengers.

Automotive . . . *More Light*

Approximately 16 per cent more light from the passing beam and 12 per cent more from the driving beam resulted upon increasing the wattage of one type of all-glass, sealed-beam, automotive headlamp from 30 to 35 watts in the passing filament and from 40 to 45 in the other.

A new reflector-type automotive utility lamp gives a lateral spread of 80 deg and a vertical of 20 deg and is designed as a back-up lamp. Used in a special holder

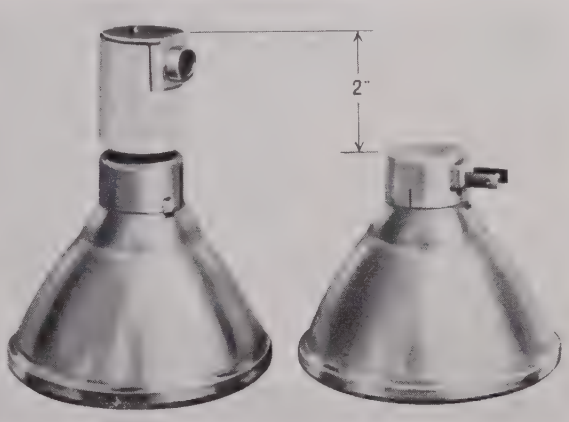


Fig. 38. The side-prong base of this projector lamp saves two inches in over-all fixture thickness, important where space-saving is paramount, in such installations as ceiling recesses, show windows, display cases, and similar applications

Fig. 39. Nearly 10 times as much light for reading aboard the Boeing Stratocruiser, in a peacetime application of a gunsight lamp. His lamp, to left of the window, and just above it, is unlighted

and supplied with sufficient cord, it is also for general utility purposes, such as changing tires at night.

For large trucks and buses, the sealed-beam fog lamp was introduced in the 12- to 16-volt rating, with either clear or amber lens.

Smaller sealed-beam spotlights were also produced, one with and the other without a nonreflecting metal cap over the filament. Omission of the shield gives a flood of lower intensity, in addition to the spot of high candlepower, for hand spotlamp or portable use.

Infrared Lamp . . . *Industrial Ovens*

Two new 125-watt infrared industrial lamps were designed to use interchangeably with 250- and 375-watt G-30 and R-40 lamps; particularly in oven applications where it is desired to maintain a given lamp spacing and distribution of radiant energy but where temperature required is considerably less than that provided with 250-watt lamps. They have advantages for preheating, for balancing temperatures in ovens where an even heat is required, or for use on finishes which might be harmed by greater energy density.

One of the new lamps has a G-30 bulb, medium-skirted base, 5-in. light center, and fits infrared reflectors now in general use. It is for use especially in open reflector ovens. The other new lamp has an R-40 reflector-type bulb and medium-skirted base. Both have an average laboratory life rated in excess of 5,000 hr.

Sunlamp . . . *Folds Away*

A new sunlamp (**Fig. 40**) folds away under the bed when not in use and swings out and up at the touch of a finger; it was produced when surveys made at Bridgeport indicated that 70 per cent of people prefer to use a sunlamp in bed. It is designed for attachme to 90 per cent of beds now in use. A built-in automa timer turns the lamp off when the desired length exposure has been reached.

Fig. 40. This Sunlamp, which folds away under the bed when not in use, is of bonderized aluminum, with gooseneck at top for adjustment, and with wire guard to protect the RS bulb

Lampholder . . . *Trigger R*

All specifications of the Certified Lamp Makers p gram are met in a new line of Trigger Ring lam holders at Bridgeport. The redesigned switch gives hi illumination in the UP position, low in the Do position, and OFF in the center. Rings on the lam holder automatically center the lamp in the husk a in the glass-bowl assembly and prevent lateral moti of the lampholder itself.

Outdoor Illumination . . . *Much More Li*

Outstanding in street-lighting developments was t introduction of a new street light placing 40 per ce more light on the street than do previously availa deflector-type luminaires. The luminaire, incorporati a new Holophane prismatic globe, will be most app priate for freeways, urban highways, boulevards, ma heavy-traffic arteries, bridges, viaducts, and seconda streets—applications where the need for 15,000- 16,000-lumen lamps and the desirability for 0.8 fo candles or more with the economies of maximum sp ing are factors. Tests also indicate the new luminaire be the best available for use with the vertical-burni mercury-vapor light source.

Erie Boulevard, in Schenectady (COVER), beca one of America's best-lighted streets with the instal tion of 82 luminaires on twin standards, in a pla parallel to the curb line. With 15,000-lumen filame lamps, the installation provides 2.7 average footcand over the entire street. The previously installed lumino arc lamps provided less than one fourth as much lig

For use with the previously announced open a enclosed suburban luminaires, to replace radial-wa reflectors on light-traffic residential streets, a new d cast aluminum hood permits direct mounting of su urban units without adapters. Interchangeable w older designs, it features improved appearance, ligh weight, and better assurance of accurate lamp foc

Economical installation, operation, and maintenan featured a new line of packaged runway lighting syste for airports. The fixtures are made by the Americ Gas Accumulator Company, and the transforme regulators, and control equipment by General Electr

The Type L-69 sports floodlight, previously used make the Yankee Stadium the best-lighted baseb park, was used to make Fenway Park in Bost equally bright. The installation contains 1120 uni A narrow-beam floodlight of similar construction w introduced for football fields and railroad yards a other installations where the floodlights must be great distance from the lighted object. Both flat a portable bases were provided for in new 500- and 10 watt general-purpose floodlights.

A new traffic-signal controller provides a choice two signal time-settings. It is particularly useful intersections subject to periodic changes in traffic flo

is room air conditioner is controlled right in the office; but it tains its heating or cooling capacity from a remotely located source

AIR CONDITIONING

TWO of the most important refrigerating-equipment developments of the year were a new hermetically sealed motor-compressor and a new condensing unit, for use in packaged refrigeration equipments such as water and beverage coolers, candy merchandisers, commercial refrigerators, display cases, vending machines, etc. The units, compact and of low height, are in five sizes in the 1/6 to ¾-hp range and in nine models to provide a wide selection. The condensing units are enclosed in a ribbed sheet-steel housing approximately 12 in. wide, 12 in. high, and 23 in. long. As well as facilitating mounting in cabinets of self-contained equipment, the housing acts as a "wind tunnel" to cool the condenser and motor-compressor. Air drawn over the motor-compressor and condenser is discharged through an open end of the housing. A rotary oil pump in the forced-feed lubrication system of the hermetically sealed motor-compressor assures maximum even distribution of lubricating oil over all moving parts, forcing filtered lubricating oil through small passages in the crankshaft itself.

Automatic Heat . . . *In a Closet*

Only two inches clearance on sides and back are required, with Underwriters' Laboratories approval, for installation of two new models of oil-fired warm-air furnaces (**Fig. 41**)—they can be installed in closets, alcoves, and utility rooms, as well as basements. One of these packaged units has an output of 60,000 Btu per hr, and the other has 85,000. High heat-transfer effectiveness and complete combustion contribute to low fuel consumption. They employ compressed air oil impact atomization of fuel, with the added feature of a horizontal rather than vertical combustion chamber. The chamber is integrated with the burner so the flame scrubs the entire inner surface, heating it evenly and eliminating "hot spots."

Air Conditioners . . . *To Heat, or Cool*

Room air conditioners, for use with remotely installed condensing units, not manufactured since conversion to war production, were redesigned and again produced. They are designed for use in offices, hospitals, hotels, and all other locations where individual control of room temperatures is desired. Containing coils, fan, filters and fresh-air inlet, they perform all the functions of air conditioning and offer individual room control even though one or more remotely located condensing unit serves a number of units. No ductwork is required, and the conditioners themselves may be modified in arrangement and application.

Units may have cabinets to blend with the interior decoration scheme of individual rooms, or they may be built into walls without cabinets, leaving only the air-discharge grille exposed to the occupied areas. A single heat-transfer surface with water as a transfer medium may be used for year-around heating and cooling. Direct-expansion coils for cooling and steam coils for heating were also made available.

Added ease of installation was attained in two newly designed self-contained air conditioners of sizes suitable for commercial application. Connections for water, drain, and electricity can be made from either side, providing greater mobility and adaptability in any type of installation where self-contained equipment is recommended. Adjustable horizontal air-discharge louvers with vertical fins are used, with either front or side air discharge, or both. For remote location of the unit, an air-discharge duct may be connected.

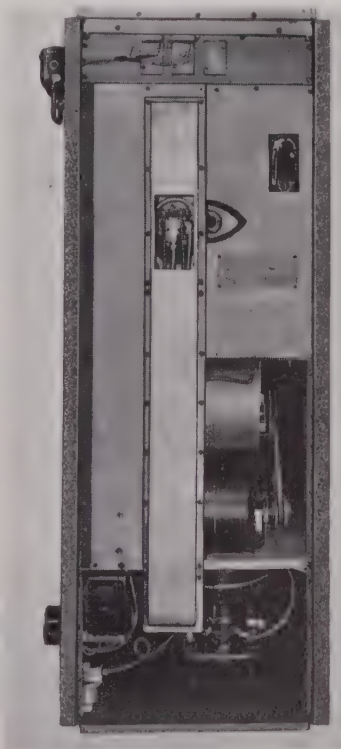


Fig. 41. An oil-fired warm-air conditioner, compact enough for installation in a closet. Front view, with access doors removed

There is plenty of easily reached freezing-storage space in this 8-cu ft home freezer

APPLIANCES

AND CONSTRUCTION MATERIALS

UPON the conclusion of the war it had been felt advisable, because of the great amount of work necessary for reconverting assembly lines to peacetime production and because of the enormous demand for electric appliances which for so long had been unavailable, to return in most cases to those models which could most quickly be put into production—in other words, prewar models. During 1947 it was deemed feasible finally to introduce long-awaited, much-heralded "postwar" models.

Laundry Equipment . . . *All-automatic*

First to operate completely automatically from the time it is started until it has completed its 45-min. soak-wash-rinse-flush-dry cycle, a new all-automatic washer (**Fig. 42**) has its entire mechanism mounted on six steel springs—vibration is so reduced that the washer need not be bolted to the floor. Rectangular, and opening at the top, the unit requires only three short lengths of hose for installation: for hot and cold inlets and drain.

The housewife simply loads the machine with up to nine pounds of assorted dry clothes, pours soap or powder into the container, closes the lid, selects the desired temperature for the wash water and the desired length of washing time, and turns on the machine. Not until the damp-dry clothes are removed—some for immediate ironing, some for further drying—does she touch the machine again.

The housewife can control the machine manually if desired, enabling her to skip any operation in the complete cycle or to repeat one. All waters are circulated continuously through filter screens to skim off dirt and lint. The washer can be set to save the final rinse water in a reservoir if it is desired to reduce water consumption. There are no exposed moving parts, and in case of power failure the water automatically shuts off.

Two new wringer washers and two rotary ironers were also introduced during the year. The washers feature full-length, to-floor skirts, and the lower-priced one incorporates a new wringer. A single-speed ironer with 26-in. roll, folds into very small space when not in use; a large ironer, with 30-in. roll and 195 sq. in. of ironing surface, is a two-speed machine.

Refrigerators . . . *Space-making*

A new, more efficient, much smaller, hermetically sealed refrigerating unit has made it possible to increase storage space by two cubic feet with the outside box dimensions remaining practically unchanged. For example, the new 6-cu ft refrigerator has the floor dimensions of the usual "four;" the new 10-cu ft those of the average "eight." The new mechanism out-performs its predecessors, weighs only 77 lb, freezes 16 lb of ice in six hours on a 100-degree day, has a frozen-storage capacity of 0.9 cu ft, and operates at a national average monthly cost of 57 cents. By way of contrast, the 1934 refrigerator weighed 143 lb, froze 12 lb of ice in six hours, had a frozen-storage capacity of 0.5 cu ft, and operated at an average monthly cost of 66 cents. Carrying the contrast back to 1927, that unit weighed 220 lb, froze only four pounds of ice, had 0.25 cu ft frozen-storage, and operated at $1.50 per month. The new refrigerator (**Fig. 43**) has: a welded sheet-steel case; an extra-large freezing compartment; better shelf arrangement; and a new Glyptal baked-enamel exterior finish that is 80 per cent more stain resistant than 1941 enamel, 70 per cent more grease resistant, 45 per cent more resistant to mars and scratches, and 20 per cent better in color retention.

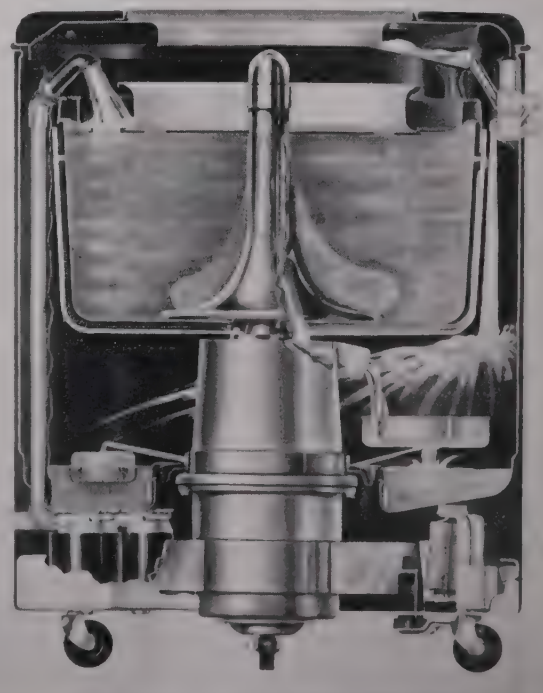


Fig. 42. The activator of this all-automatic washer soaks, flexes and rubs the clothes gently from 3 to 20 min as desired. In the 8-min drying cycle the washer basket spins the clothes at up to 1140 rpm

An eight-cubic foot home freezer which holds 280 of assorted frozen food, was added to the line which luded also one of 4-cu ft capacity. The freezing- rage space measures 39½ in. long, 17½ in. wide, and in. deep. Four removable wire baskets facilitate ndling of the foods stored in the chest.

A new refrigerator has two separately refrigerated l completely insulated compartments, each with its n control and its own door. The upper compartment, cu ft in volume, can be adjusted from 0 to 10 F l is for freezing of foods and long-time storage of zen foods. The lower compartment, of 6.7 cu ft, intains a temperature of about 38 F for fresh-food rage. It is unnecessary to defrost the fresh-food npartment. The freezing compartment requires de- sting only twice a year.

nges . . . *Faster*

New slim-line Calrod cooking units have had the l length increased up to 49 per cent to provide more ting surface and a quicker response either up or wn; and life of the units has also been lengthened. The deluxe range has a built-in six-quart aluminum ssure cooker for occupying the deep-well position ich is used only for nonpressure cooking in other nges. The pressure-cooker utensil may also be used a surface unit; or, used with a simple flat lid which lso provided, it serves as a conventional thrift cooker. e five-speed, 1250-watt Calrod unit in the bottom the well can be lifted to the surface and used as a urth surface unit. Broiling power of this range was reased 25 per cent by widening the heating unit and reasing its wattage; baking speed may be similarly reased by converting the oversize oven to the small peed oven," merely by raising the lower 3000-watt lrod unit to the center of the large oven.

shwashers . . . *More Convenient*

Among improvements in dishwashers were a new ter inlet, facilitating installation; a redesigned oper- ng-control assembly, providing more positive action; d a redesigned cabinet, permitting more accessibility the interior of the electric-sink model.

aters . . . *Heat-wrapped*

New water heaters were equipped with a "Heat- rap Calrod" unit which consists of one, two, or three bons of Calrod that encircle the water-heater tank d that are held tight against the surface by stainless- el channels. The scaling or corrosion suffered by im- rsion units is avoided, and the unit may be placed ser to the bottom of the tank for maximum delivery hot water.

In areas where advisable, the new heaters can be uipped with a special magnesium-alloy tube to reduce rrosion of galvanized tanks. The tube serves as the ode and the galvanized tank as the cathode, and er a period of time the magnesium is deposited on e tank to give it protection against corrosive water.

For that 25 per cent of the population who sleep in twin or single beds there was produced an automatic blanket that is 66 in. wide.

Fig. 43. This 8-cu ft refrigerator occupies only the floor space of its 6-cu ft predecessor

For that much greater percentage of the population —seven out of ten—who have trouble keeping their feet warm at night during cold weather, a foot warmer was announced. Of Sanforized cotton and measuring 36 by 17 in., it is placed between the first sheet and blanket and maintains the foot of the bed at warmth of 105 F throughout the night.

A waterproof heating pad, for both wet and dry heat applications, has the electric heating unit and cord completely sealed. It has a full range of three fixed heats—low, medium, and high.

A double-duty steam iron can be transformed automatically into either a steam or dry iron at the turn of a control knob. Only the exact amount of steam necessary for the fabric being ironed is produced, and the steam shuts off automatically when the iron is set on the heel rest.

A new electric casserole has a four-quart capacity and weighs only 4¾ lb. One model has automatic temperature control from 100 to 550 F, and another has two-heat control for fast and slow cooking.

Vacuum Cleaners . . . *Midget*

The problem of cobwebs and dust in difficult corners was simplified by a midget tank-type vacuum cleaner so light (7½ lb) it can be slung from the shoulder. It has 75 per cent of the suction power of a full-size tank-type cleaner, although only 14 in long and about six inches wide and high. A flexible hose, two extension tubes, and five slip-on attachments are included.

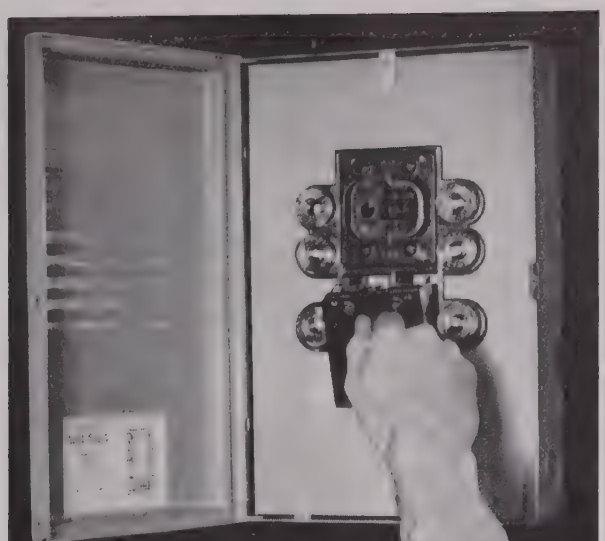


Fig. 44. Pleasing appearance is only one feature of this new pull-out switch

Clocks and Timers . . . *Pin-up or Table*

New clocks announced at Bridgeport included a 30-min kitchen timer; an alarm clock that serves also as a bedside lamp; a kitchen-wall clock with built-in appearance; and a low-price alarm for the mass market.

Telechron Inc. of Ashland (Mass.), a G-E affiliate, announced a combination wall pin-up and table-type alarm clock. The back has a keyhold slot for mounting on a screw or other suitable support. For table mounting, the base is easily removed by two snap fasteners. Alarm and time-set knobs are at the front.

A panel-mount 60-min Telechron timer movement, for range and appliance use, was designed with buzzer signal only, signal and 15-amp switch, or switch only, for either normally-open or normally-closed operation.

A wall-mounted advertising clock with lamp illumination behind a translucent dial was also developed at Ashland. Colored designs on the 14½-in. dial or crystal are made to the advertiser's specifications.

Wiring Devices . . . *All-plast*

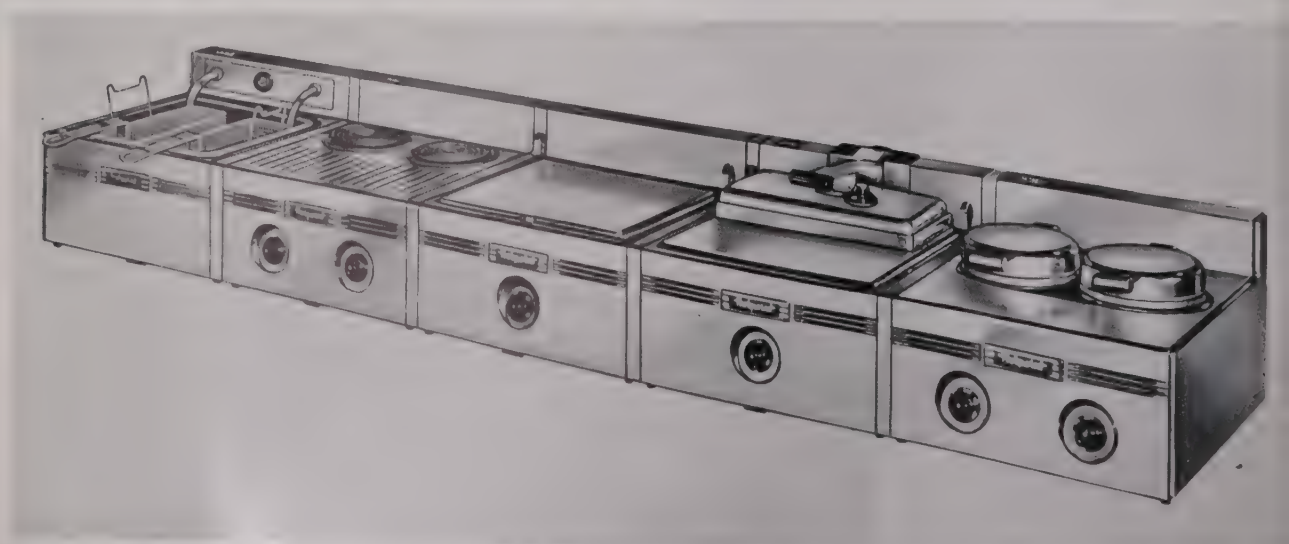
All-plastic construction of sockets and ceiling rece tacles, announced by The Monowatt Electric Corpor tion of Providence (R. I.), a G-E affiliate, results no outer metal shell to tarnish, ground, or short circui and no paper liners to absorb moisture or char fro the heat of high-wattage lamps. The product is n affected by oil, moisture, or corrosive vapors, a wiring is simpler and faster. The combination sid outlet, pendant, and threaded nozzle-cap saves stockin three different sockets, since for side-outlet use t plastic barrier can be punched through easily with screwdriver.

The chain-pull body without the cap on the ne socket permits its use as a combination 3¼- and 4-i ceiling receptacle by mounting it in a plastic plat This arrangement results in a much lighter and strong ceiling receptacle than the previous porcelain constru tion. It also eliminates the necessity of stocking tw sizes of porcelain devices. The two new sockets a the new ceiling receptacle replace eight of the previo items—of advantage in the stock-room.

Switches . . . *Twi*

Thirty-ampere type D safety switches were designed by Trumbull Electric Manufacturing Co pany of Plainville (Conn.), a G-E affiliate, as twins f either plug or cartridge fuses, with 94 per cent of t parts common to both. Bearing Underwriters Labor tories approval, the devices offer front operatio straight-through wiring terminals, adequate wiri gutters, and numerous properly located knockouts.

A new fuse puller switch (**Fig. 44**) continues t Trumbull standardization and appearance program It offers: two series- or parallel-connected, 60-amp ma or branch circuits and four, six, or eight 30-amp plu fuse circuits; easily accessible solderless termina numerous knockouts to fit any required arrangemen and protective shield.



A custom-matched line of five electric commercial counter cooking appliances can be combined into any arrangement by use of a banking strip or can be u as individual units. The complete counter kitchen shown here includes (left to right) the electric fry kettle, hotplate, griddle, griddle-grill, and waffle baker, is only 7½ ft long. Produced by Hotpoint, Inc., a G-E affiliated company, the line increases cooking-surface capacity for sandwich shops and other coun restaurants as much as 70 per cent. Direct immersion of the Calrod heating element into the fat is one of the new features of the electric fry kettle. The gridd grill is a new appliance, combining the cooking speed of the grill with the large frying area of the griddle

light weight of this all-plastics 9-ft dinghy gives it exceptional ed; and its seamless, one-piece construction makes it safe and nomical. It requires practically no maintenance, is unaffected by elements, and is attacked by neither salt water nor worms

HEMICAL AND IETALLURGICAL

PLASTICS, SILICONES, RESINS AND INSULATIONS

. . . . . .

HEMICAL and metallurgical developments which broadened the scope of applications for plastics, cones, insulating materials, and metallurgical prod-s, and which promise to open still more new fields in coming year, supported a very considerable increase he manufacturing facilities of the Company's Chem-l Department during the year. New plants were lt at Anaheim (Calif.) for Glyptal alkyd resins, at terford (N. Y.) for silicones, and at Coshocton hio) for laminated plastics; and a plant was obtained molded plastics at Decatur (Ill.).

n the field of plastics there was the development a heat-resistant molding compound. The first all-stics rowboat was designed and manufactured, and ize record was set in making a 650-lb laminated stics part for a synchrotron.

There were many new applications for silicone oils, a new use for bouncing putty, and a new silicone adhesive.

Metallurgical developments included the introduction of new Alnico permanent-magnet holding assemblies, design of an ion trap for television tubes, a magnetic vibrator assembly to test magnets, and improvements in various alloys.

Resin and insulation advances included a solventless, cold-setting, casting resin; a varnished cloth combining insulating and adhesive properties, and improvements in Glyptal resins for enamels.

PLASTICS

Heat-resistant Compound . . . *For Oven Dishes*

A NEW phenolic resin, R-106, made possible a high-heat-resistant compound suitable for such uses as plastic knobs and handles on oven dishes. Parts retain their properties up to 300 F. and for short periods of time up to 500 F.

All-plastics Boat . . . *9 Ft, 80 Lb*

The all-plastics boat, an unusually strong 9-ft dinghy weighing only 80 lb, yet holding loads exceeding 1500 lb, was produced for the Beetle Boat Company, New Bedford (Mass.). Believed to be the first of its kind molded completely of synthetic materials, it is of a glass mat with woven cotton interlayers and a polyester resin, in thickness from $\frac{3}{32}$ to $\frac{1}{4}$ in. It is laminated

Fig. 45. Big parts for a big machine—Plastics rings and plastics manifolds for a synchrotron, offering unusual strength and stability combined with electric insulation, as required by the 300,000,000-electron-volt atom-smasher

by the low-pressure process and is cured in a closed mold under a pressure of 20 psi at approximately 220 F. in about two hours. Cellulose acetate plastic foam in seats and gunwale give it permanent buoyancy.

Largest Ever . . . *For Atom-smashing*

Seven huge plastics rings and three plastics manifolds (**Fig. 45**) were produced for use in the electron-accelerating vacuum chamber of the 300,000,000-electron-volt synchrotron of the University of California. Made of a glass-mat material and laminated under low pressure, one of these rings, weighing 650 lb, is the largest plastics part ever produced.

Sealing Sleeves . . . *Advantages Aplenty*

A new application for polyvinl chloride sealing sleeves as insulating covers on magnetic coils is more effective, less costly, less time-consuming than conventional wax, cellulose acetate, or wrapped insulations, and its use enables large quantities of coils to be wound as one piece on long mandrels and cut to desired sizes. A dilated sleeve is slipped inside the coil, the two ends are turned back over the outside, and the sleeve allowed to dry and shrink to an effective tight-fitting insulation.

SILICONES

EMULSIFIED silicone oils were applied as mold-release agents in the manufacture of such molded rubber products as tires, shoe soles, and heels; they give an improved compound flow to all parts of the mold, resulting in a more attractive finish. A heavy-viscosity silicone oil, applied as a damping medium in a torsional vibration damper on diesel-engine crankshafts, is more stable and shows minimum viscosity change with temperature. Another application was in hydraulic timer devices for household appliances.

Faster production of molded silicone rubber was achieved with a pin-and-plunger locking device since by its use a number of molds can be serviced by one press during a pressing-curing-cooling cycle.

An interesting application of silicone resins was in coating bread pans and baking tins. A coat of the resin, lasting for several hundred baking cycles, eliminates the need for greasing pans.

Bouncing putty was applied by Blake Industries of Detroit in a product, the Levelmatic, that automatically adjusts table-legs to uneven floors or rugs, up to $\frac{3}{16}$ in.

The scope of applications for silicone rubber was greatly broadened by development of an adhesive for bonding the rubber to itself, or to metal, glass, ceramics, and other materials. Modified compounds were produced for potting and caulking uses. Use of the adhesive makes possible the building up of gaskets of large di ameter, otherwise too cumbersome or uneconomica for production.

RESINS AND INSULATIONS

Cold-setting Permafil, a casting resin of 100 per cen solids, was developed for filling, potting, and moldin applications. It is infusible, has excellent electrica qualities, and is produced both as a flexible and as rigid product. It has less volume shrinkage, a lowe operating temperature, and higher oil resistance tha conventional potting and filling materials.

The need for liquid adhesives in the wrapping of slo portions of armature and stator coils was eliminate by introduction of an adhesive-coated varnished clot combining insulating and bonding qualities in on product.

Higher gloss, easier brushing, greater resistance t washing and scrubbing, and better gloss retention wer attained by improvements in Glyptal resins for archi tectural enamels. Better drying characteristics an weather-resistance were likewise effected in Glypt resins for automotive refinishing.

A plastic tower head assembly for an aircraft antenna pattern plotter, mad from Textolite for Airborne Instruments Laboratory, Inc. Consisting of mo than 25 precision-machined plastics parts, the tower head is designed rotate scale-model airlpanes on a high-frequency radio field so that the tran mitter signals can be received and recorded as a function of the model rotation

METALLURGY

ico Magnet Assemblies . . . *Standard Line*

INIMUM space requirements and maximum holding power were much in mind in the develop- t of a standard line of Alnico permanent-magnet ding assemblies which effect economy and efficiency eliminating the necessity for making each new embly application to particular specifications. There five types in 17 sizes, ranging in pull from 1½ to lb. Some types are vacuum-impregnated to prevent sture penetration and consequent internal rusting are cadmium plated against external corrosion. ay magnetic fields do not affect the new assemblies, they retain life indefinitely.

Close Flux" assemblies were produced in cup, cup- n, and horseshoe types, for use where the required ding force is through a zero air gap and an extended gnetic field is not required. "Deep Flux" assemblies, sessing a magnetic field extending to a far greater th, were made available in magnetic retriever and gnetic stand types.

he magnet assemblies are designed for applications far apart as department stores and chemists' lab- tories. They can be used for supporting department- re manikins and holding signs and cards; for support- ferromagnetic parts for spraying, painting, plating, l dipping operations; for overhead conveyor work; retrieve tools and weapons from lakes or holes; and convenient and rigid supports for mounting lenses l light sources in laboratory optical systems.

roved Magnets . . . *Impregnated Vectolite*

mpregnation of Vectolite, a sintered mixture of iron l cobalt oxide, with Permafil resulted in a better face finish, more waterproof and much stronger, and ransverse rupture strength about 4½ times that of reated Vectolite.

Alnico magnets with iron backing were pressed and tered. The soft iron backing provides high-permea- ty return path without necessity for grinding the gnet and cementing a separate iron back to it; and ero air gap is assured.

Addition of more nickel to the composition of alnico produced increased coercive force, a feature of ad- ntage for applications where severe demagnetization uences are encountered, as in motors and generators.

A method for sintering Cunife, another magnetic oy, at a temperature considerably higher than the lting point of copper was developed. Cunife contains per cent copper, so it is interesting to note that the mpressed powders do not melt but retain the shape ginally pressed.

oys . . . *Better Contacts*

Hevimet, a high-tungsten nickel-copper alloy, was nounced commercially. Made with a very fine tung- n powder, its ultimate tensile strength is in the ler of 115,000 psi.

Louvered germicidal ultraviolet lamps are directed at the upper air in infant nurseries, wards, and tuberculosis hospitals

ELECTROMEDICAL EQUIPMENT

X-Ray Equipments . . . *Bus for Cancer*

THE first x-ray-equipped bus for diagnosis of cancer was delivered in August to the Kentucky division of the American Cancer Society. Produced by the General Electric X-Ray Corporation at Chicago, this first mobile unit will act as a diagnostic "extension arm" for the network of 16 cancer-detection clinics in that state. In exterior appearance similar to x-ray buses for tuberculosis control, the equipment includes a combination radiographic-fluoroscopic table, vertical cassette-holder for chest radiography, darkroom, biopsy table, and numerous accessories.

Development of a new superficial-therapy x-ray unit was another major accomplishment of the year. Equipped with a beryllium-window tube, the unit can provide a beam of essentially zero filtration, ideal for skin work, and for a superficial-therapy machine, delivers an unprecedented number of roentgens per minute: At 30 cm, 100 kv, 5 ma, no filter, it delivers 900 roentgen units; at 7½ cm (in contact with the head without cones), 100 kv, 5 ma, no filter, this figure becomes 14,000 roentgens per minute. Recommended range of operation is from 30 to 100 kv. Intensity of radiation is constant, to within a very low percentage, through an included angle of 30 deg.

A versatile bi-plane fluoroscope, previously special equipment, went into quantity production, offering a means of greatly simplifying bronchoscopy and orthopedic work. It can make vertical, horizontal, and angular fluoroscopic and radiographic examinations without disturbing the patient or shifting portable x-ray apparatus into position. It can also be used for general fluoroscopy and radiography, for spot radiography, and

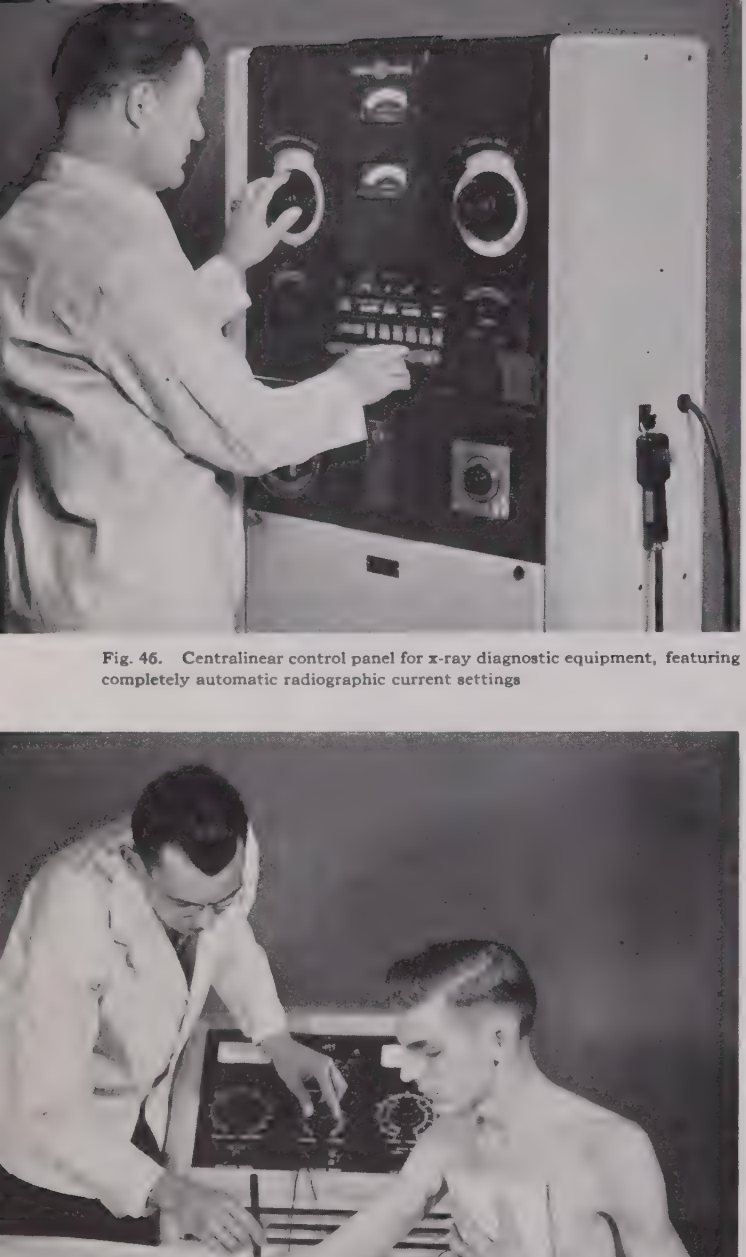


Fig. 46. Centralinear control panel for x-ray diagnostic equipment, featuring completely automatic radiographic current settings

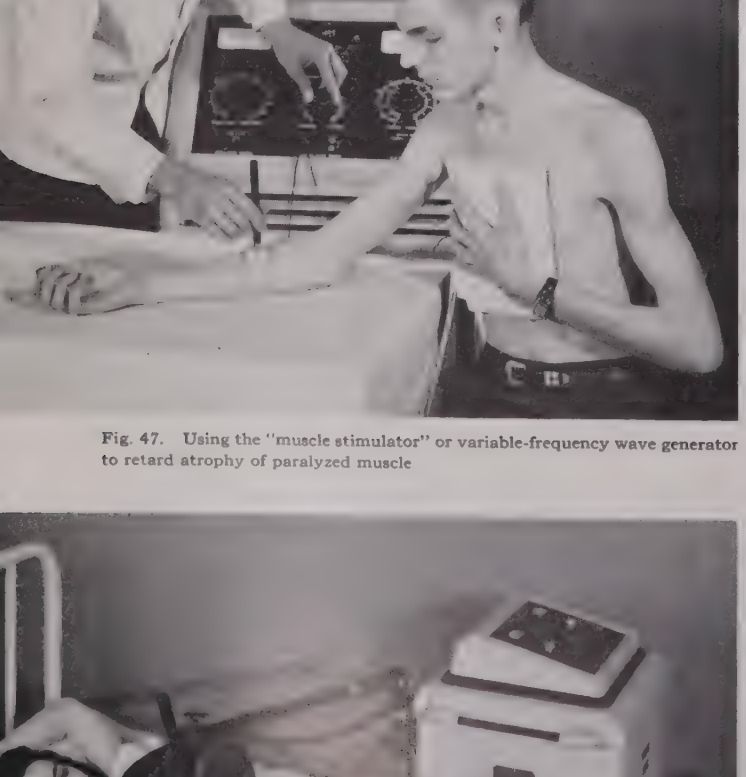


Fig. 47. Using the "muscle stimulator" or variable-frequency wave generator to retard atrophy of paralyzed muscle

for "flash" fluoroscopy at 5 to 20 ma. It automatical selects the proper tube for fluoroscopy.

A new type of centralinear vertical 200-ma contr panel (**Fig. 46**), perfected for x-ray diagnostic equi ment, reduces the number of movements required make an exposure from ten movements to six and fe tures push-button operation. Radiographic curre settings are, for the first time, completely automati All internal parts are reached easily through a fron opening panel without moving the unit away from th wall.

Other Equipments . . . *Muscle Stimulat*

Officially known as a variable-frequency wave gene ator, and popularly as a "muscle stimulator," is a devi (**Fig. 47**) developed to retard atrophy in denervate paralyzed muscles. It supplies alternating current pure-sine-wave form which can be varied (with th patient in the circuit) from two cycles per minute 100 per second. The equipment produces vigoro muscle response at low current intensities which a tolerated by young children and adults with relative little discomfort. Clinical investigation has shown tha stimulation retards atrophy in denervated muscles, thu maintaining the muscle at as near normal volume possible, so that upon nerve regeneration the disabilit time and percentage disability are reduced to a min mum.

A germicidal lamp was developed with speci louvers to restrict radiation to a specified zone, thu effectively protecting occupants of the room again injurious effects from either direct or reflected radiatio Heating and ventilating systems are limited by m chanical considerations, and by danger of creatin objectionable drafts, to an amount of air flow not e ceeding six to twelve changes per hour. Germicid ultraviolet, however, by irradiating the upper are through which the room air is normally constantly ci culating, can provide disinfected air at a rate equal 120 air changes per hour.

To meet the demand of the medical profession for lamp which would help prevent the public from buyin worthless or hazardous lamps in "over the counte sales," a "prescription" ultraviolet lamp was produce which the patient can use under the direction of physician. It can also be used as an inexpensive sourc of ultraviolet radiation in hospitals that require number of lamps for individual bedside use. It utiliz the 250-watt, quartz, high-pressure, mercury-a burner.

A new inductotherm (**Fig. 48**) features improve crystal control so that frequency variation is less tha ± 0.05 per cent, meeting the stringent new FCC regula tion as to frequency control and harmonics. Harmonic have been reduced well below that necessary to elim inate interference with established services.

Fig. 48. A new inductotherm producing heat deep within the tissues wit out contact has improved harmonics and frequency control

o of these locomotives, the world's longest single-cab units, speed ssenger and freight trains over the steep grades of the Cascade ountain section of the Great Northern between Wenatchee and komish

TRANSPORTATION

AIR SEA LAND

• • • • • • •

MARINE

TWO new American President Lines trans-Pacific liners (**Fig. 49**), the *President Cleveland* and the *resident Wilson*, were among the year's most outstand-g ships. The first was delivered by the Bethlehem ipyards at the end of the year, and the other is heduled for early 1948 delivery. Passenger quarters e featured by safety, comfort, recreational facilities, id luxuriousness; and the propulsion equipments are st as noteworthy.

Each liner is powered by two of the most modern 00-hp turbine-electric units, each normally rated 6890 w, 3600 rpm, 3500 volts, three-phase, 60 cycles, 1.0 ower factor, and with a continuous maximum rating 7650 kw at 3610 volts and 3715 rpm. Steam conditions the turbine throttle are normally 590 lb gage and 5 F total temperature, with an allowable maximum 600 lb gage and 850 F total temperature. The totally nclosed synchronous motors for propulsion are each ormally rated 9000 shaft-hp at 120 rpm and 10,000 haft-hp maximum at 124 rpm. Each turbine-generator ormally supplies power to an indivdual propelling otor, but cross-over connections are provided for driving both motors in parallel from either turbine-generator at reduced power and speed. Two 600-kw turbine-driven auxiliary power generating sets are installed in each engine room.

A distinctive feature is that the propulsion turbine-generator sets are located amidships, each in a separate engine room. Each propulsion motor is placed aft in its own compartment, thus eliminating long shafts and shaft tunnels and increasing the carrying capacity of the ships.

Merchant Vessels . . . *For Peacetime Use*

At least 30 ocean-going vessels were delivered by shipyards to private owners here and abroad. Included were some under construction for the war fleet but completed for peacetime use. Of these, 18 vessels totalling 126,500 hp were equipped with G-E propulsion turbines. Typical of vessels completed as peacetime ships was the *Del Sud*, built at Ingalls Shipbuilding Company for the Mississippi Shipping Company. The Federal Shipbuilding and Dry Dock Company completed two special vessels, the bulk-cargo carriers *Gypsum Queen* (**Fig. 50**) and *Gypsum Prince*.

Fig. 49. *President Cleveland* and *President Wilson* as they neared completion in the Bethlehem shipyards at Alameda (Calif.). Each is 609 ft over-all, has a maximum speed of 21 knots, passenger capacity of 550, and crew of 340

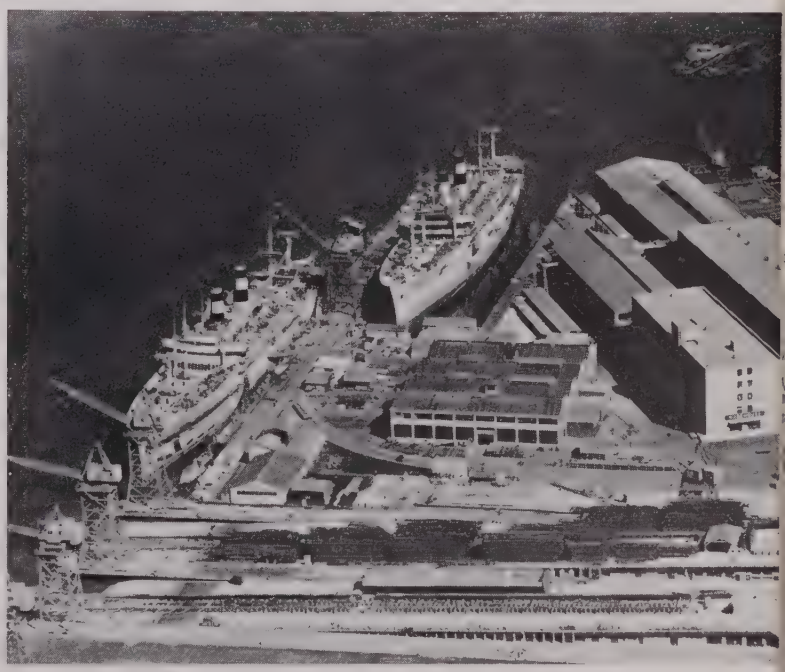


Fig. 50. S. S. *Gypsum Queen*, a special bulk-cargo carrier powered by a 2700-hp geared turbine

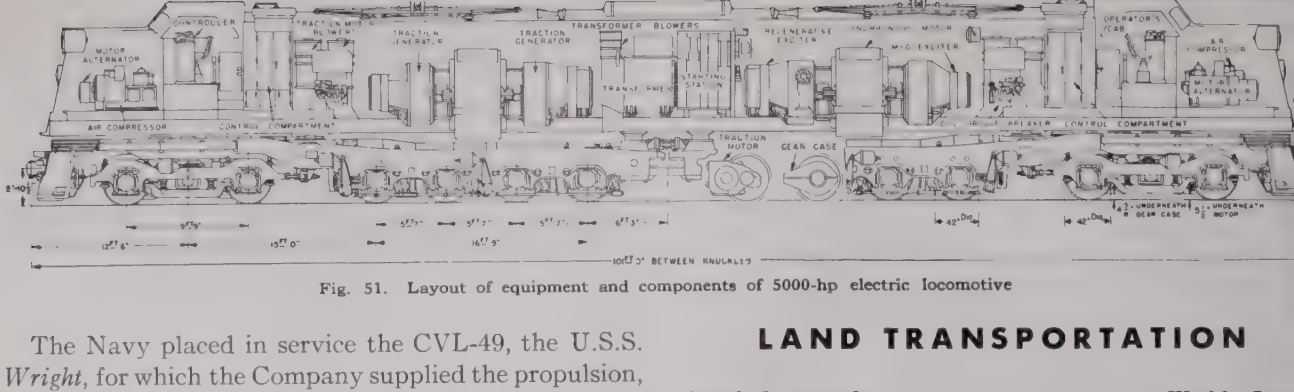


Fig. 51. Layout of equipment and components of 5000-hp electric locomotive

The Navy placed in service the CVL-49, the U.S.S. *Wright*, for which the Company supplied the propulsion, and auxiliary ship-service generating equipment. Also into service went U.S.S. *Lloyd Thomas*, the DD-764 built by Bethleham Steel Corporation, for which it supplied emergency generating equipment.

Cargo Winch . . . *Topping*

A new application in the marine field was the cargo boom topping winch, push-button controlled and hence reducing accidents as well as speeding cargo movement. One type is mounted on the deck; another is self-contained and mounted on the mast. The winch is worm-gear driven by a 3- or 5-hp electric motor.

Communication . . . *And Radar*

The electronic navigator, or marine radar, went into production and was installed on such widely varying vessels as private yachts, ferries, tankers, ore-boats, tugs, cargo ships, and passenger liners. An improved antenna was provided, giving more accurate "vision."

For small-boat owners, there was produced a compact radio-telephone unit containing a complete four-channel transmitter and receiver, enabling the user to communicate with other boats, the U.S. Coast Guard, or with the land-telephone system. Installation is simple, and operation requires even less skill than does operation of a dial telephone.

Two-way FM radio communication was installed by the marine division of the New York Central Railroad to speed up its movement of lightered freight in New York Harbor. Transmitting and receiving antennas on top of a 218-ft grain elevator at Weehawken (N.J.) permit the dispatching office to make immediate contact with any of 24 tugs in the harbor to cancel or supplement orders issued when the vessel left pier.

The Freedom Train's diesel-electric locomotive, "The Spirit of 1776," a 2000-hp unit, is finished in gleaming white, with red and blue trim. An Alco-G.E. locomotive, it is capable of 120 mph

LAND TRANSPORTATION

Electric Locomotives . . . *World's Larg*

THE world's longest single-cab all-electric locomotives, Great Northern's two new rail gia went into service speeding passenger and freig trains through the Cascade tunnel, the western he sphere's longest. Each weighs 720,000 lb, is 101 ft lo and can pull a 2000-ton train without helper serv over the 2.2 per cent grade on the Great Norther main-line electrified section.

Designed primarily for heavy mountain service, t Class B-D+D-B 11,000-volt, 25-cycle, single-ph motor-generator locomotive (**Fig. 51**) has a continuo rating of 5000 hp at the rail with 119,000 lb tract effort at a speed as low as 15.75 mph. Tractive eff is 180,000 lb at 25 per cent adhesion. All weight is drivers. Each axle is motor-driven. Maximum regen ative braking is provided. The locomotives may be us in tandem and have operating stations at each end.

Shipment was started on four 6800-hp, 500-ton, tw cab, 11,000-volt motor-generator locomotives for t Virginian Railway. These are the most powerful co tinuous-rated locomotives ever built, and first of a type with a million pounds on drivers.

Also for the New World were eighteen 182-ton 30 volt d-c streamlined passenger locomotives shipped the Paulista Railway, Brazil, and nine similar locom tives and six sets of cabs and trucks for the Cent Railway of Brazil. For the Old World, twenty 273-t 3300-volt d-c locomotives were under construction. I the Lake Front Dock and Railroad Terminal Compa twelve 30-ton 36-in. gage 250-volt side-arm push type locomotives were made.

Diesel-electric Locomotives . . . *Increased Ra*

Improvements were made in the 65-ton dies electric switching locomotive to increase the norm horsepower rating from 400 to 550 hp and fuel cap ity from 250 to 400 gal to furnish additional runn time for this power. Double-reduction motors w smoother, quieter hypoid gears are used, and metal return circuits have replaced the grounded-return s tem. Among new safety items are extra-fast cl brakes, stair-type side-steps, and hinged windows wh afford better ventilation.

Changes in the 80-ton switcher include a hig continuous rating, one-shot lubrication of metal gear and axle bearings, new radiator-ventilation control, a

tallic-return circuits. The generator and air com-ssor were made more accessible, and the transition nt was eliminated.

Under construction for the Argentine State Railways re 130 streamlined, high-power, heavy-duty, meter-ge diesel-electric locomotive cabs of three designs. ipment was completed on forty-two 70-ton 600-hp ter-gage locomotives for the Sorocabana Railway of azil.

A new motor-control equipment was made standard all new Alco-G.E. diesel-electric road locomotives, 00- and 2000-hp units, several of which have gone in vice. The new magnetic-amplifier control regulates e amount of series field shunting according to a pre-termined sequence. It operates with changes in the nerator armature current and is effective in any of e three usual motor connections: series, parallel, or ies-parallel. The device controls the generator cur-nt output with an accuracy of one per cent. With no cuum tubes in the circuit, the equipment lends itself the usual railroad type of electric maintenance.

ne Locomotives . . . *Compact Motor*

A new line of box-frame traction motors features mpact design, with resulting greatly increased me-anical and electrical capacity for a given space. A mpletely sealed axle-bearing lubrication system, nservative bearing loading, small shaft deflection, d armature bearings sealed from dirt help make for ger mechanical and electrical life.

A four-axle, 25-ton 480-hp haulage locomotive ently placed in service led to the development of a ger, 30-ton equipment and also a 40-tonner equipped th dynamic brakes. Air brakes, hand brakes, dynamic aking, and track brakes are all incorporated in two -ton, two axle, high-speed (40 mph maximum) mine-ulage locomotives under construction during the ar. Two-station control arranged for either single-it or tandem operation features two 10-tonners for e Peabody Coal Company.

ban Transit . . . *Larger Subway Cars*

Car builders were developing new, large subway rs for the City of New York during the year. The dependent-B.M.T. Divisions will receive 400, and e I.R.T. Division 350, during 1948 and 1949. The mer will be 60 ft long, seat 56, and have a maximum ssenger capacity of 300. Because of clearance limita-ns, the latter will be 51 ft long, seat 44, with room a maximum of 200.

There will be four motors per car—one for each axle, ving an even distribution of accelerating and braking ort. The new 100-hp motor will have an accelerating e of 2.5 mphps up to maximum load and a braking e of 3 mphps with seated load. The motors will be lted to the truck transom and cushioned by the ck springs against track impacts. Each will have its nature shaft parallel to the truck axle and connected rough a flexible coupling to an oil-tight gear case ntaining a helical spur pinion and gear.

Fig. 52. Douglas D-558 Skystreak, with single axial-flow turbo-jet engine, new holder of world's speed mark, with 650.6 mph

A new, fully automatic control has plenty of steps for smooth acceleration and braking at any passenger load. Each size of car will have the same capacity electric equipment. Air brakes will supplement the motor brake and normally will be locked out at speeds above 10 mph. Brake cylinders will be mounted on the trucks to eliminate the conventional foundation brake rigging.

Coil springs, vertical and lateral shock absorbers, and liberal use of rubber insulation between metal contacts will improve riding qualities and reduce noise. Seats will be covered with sanitary, easily cleaned plastic. Narrow side posts and recessed interior contour under the window sills will provide wide aisles and longer seat cushions. Doors 50 in. wide will reduce the time for passenger interchange.

A developmental 10-car train under construction during the year, for 1948 delivery, has its electric equipment fundamentally similar to those cars, but each motor will be mounted with its frame parallel to the rails and will drive through a shaft perpendicular to axle, using hypoid gearing. Resilient wheels with rubber inserts will be used, so a brake drum on each axle will dissipate the heat from the shoes. The body will be of special weight-reducing alloy, and the interior will be force-ventilated by air from which dirt has been electrically precipitated as it passes over sterilizing lamps.

AVIATION

THE past year was an eventful and significant one in the annals of aircraft-gas-turbine progress and in the development of electric equipment for the aviation industry. Many new jet-powered military airplanes took to the air for the first time and distinguished themselves by remarkable performance records; and not only were adaptations made of wartime designs of electric equipment for use in peace, but research and fundamental development went ahead at a rate comparable with that maintained during the war years.

Jet-propulsion . . . *Records Smashed*

The most noteworthy air record was that of the Douglas D-558. This Skystreak (**Fig. 52**), equipped with a single axial-flow turbo-jet engine, set a world's

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Fig. 53. The North American XB-45, a new four-jet bomber

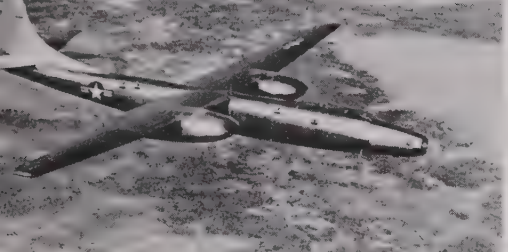


Fig. 54. The Consolidated Vultee XB-46, four-jet bomber

Fig. 55. Boeing's XB-47 has six turbo-jets

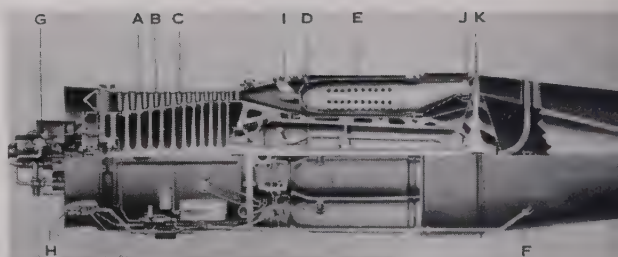
Fig. 56. The Martin XB-48, also with six turbo-jets

Fig. 57. The YB-49, Northrop's Flying Wing, is powered with eight jets

speed record of 640.7 mph on August 20, and in l
than a week increased the mark to 650.6 mph.

Two four-jet bombers flew for the first time. Th
were the North America XB-45 (**Fig. 53**) and C
solidated Vultee's XB-46 (**Fig. 54**). There were t
planes—Boeing's XB-47 (**Fig. 55**) and the Mar
XB-48 (**Fig. 56**)—with six turbo-jets each. Northro
huge YB-49 (**Fig. 57**), the Flying Wing, also ma
its initial flight; it is powered with eight jets. In t
single-engine fighter-plane class there was also t
XP-86, with swept-back wings unveiled by No
American with initial flight October 1.

The year marked the transfer of design and manuf
turing responsibility for the TG-180 engine (**Fig.**
to Allison Division of General Motors. General El
tric's vastly expanded aircraft-gas-turbine facilit
were devoted to the manufacture of higher-powe



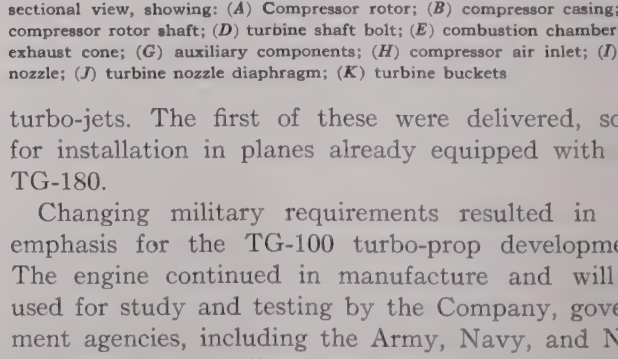


Fig. 58. Here (*top*) is the widely used TG-180 turbo-jet, and (*belo*
sectional view, showing: (*A*) Compressor rotor; (*B*) compressor casing;
compressor rotor shaft; (*D*) turbine shaft bolt; (*E*) combustion chamber
exhaust cone; (*G*) auxiliary components; (*H*) compressor air inlet; (*I*)
nozzle; (*J*) turbine nozzle diaphragm; (*K*) turbine buckets

turbo-jets. The first of these were delivered, so
for installation in planes already equipped with
TG-180.

Changing military requirements resulted in
emphasis for the TG-100 turbo-prop developme
The engine continued in manufacture and will
used for study and testing by the Company, gove
ment agencies, including the Army, Navy, and N
C.A., and by propeller manufacturers.

Turbosuperchargers . . . *"Compound*

Boeing's Stratocruiser (**Fig. 59**), initially flown
July, became the first turbosupercharged passen
airplane. Likewise assisted in attaining peak perfo
ance at high altitude by reason of the turbosup
charger was Boeing's B-50, larger and more powe
than the famed B-29, which also had its first flights

Ignition . . . *For New Transp*

Vast quantities of high-tension ingition systems w
furnished during the war to the Air Forces for use w
the R-2800 engine of the Douglas A-26, North
P-61, and Republic P-47 airplanes. A refined type

g. 59. The Boeing Stratocruiser is the first turbosupercharged passenger plane

is ignition system is being supplied for use on several ew commercial transports. First installations are being ade on the Martin 202. Development work was also rried on for high-frequency low-tension ignition for e new and larger Pratt and Whitney R-4360 engine, be used on the Boeing B-50 airplane. Similarly, both velopment and production went forward in the field ignition for jet engines.

rmament . . . *Entirely New*

Work on aircraft-armament equipment during the ar served as an excellent foundation for further work 1947. An entirely new remote-control turret system as developed for the Consolidated B-36 (**Fig. 60**), e world's largest land-based bomber.

Engineering work of development nature proceeded armament systems for jet-propelled planes as yet ly in the design stage. Light-weight radar, high-curacy gyroscopes, and high-speed electric computers so underwent improvements.

ectrical Load . . . *Still Growing*

Electrical loads on both military and commercial rplanes increased considerably during the year, de-anding increased consideration to problems of power neration, regulation, distribution, and protection. noteworthy solution to such problems was found in e load center, a quickly removable panel including oltage-regulator and bus protective devices. They were eing installed on the Convair 240 airplane. The Douglas DC-6, Lockheed Constellation, Lockheed onstitution, and Boeing Stratocruiser also called for arious new components, including generators, volt-ge regulators, and circuit breakers.

With continued electrical load growth on modern rge airplanes, the cable weight for a 27-volt d-c ystem has become appreciable. To achieve minimum eight of cabling and power-utilization equipment, the lectrical system of the Convair B-36 was selected to be 08 volts, three-phase, 400 cycles. Since the generators ere to be driven by the main propulsion engines, it was necessary to develop means of providing constant generator speed over the engine speed range of 800 to 3000 rpm. In conjunction with the Sunstrand Company, such a hydraulic drive and governor combination was developed with a rating of 40 hp. Not only the B-36 but also the Northrop B-35 Flying Wing has such a drive.

Flight Recorder . . . *Required Equipment*

Knowledge of the cause of past accidents is a primary factor in the elimination of future ones. A new instrument, the flight recorder, was developed to record altitude, vertical acceleration, air speed, and direction, with one instrument at a remote location. The recorder is usually mounted in the tail section, where it is least likely to be damaged in event of an accident.

The records are of additional value in air-line management and engineering because they present a picture of the operation of a given flight, thereby indicating the degree of adherence to the flight plan and other instructions of operation. The Civil Aeronautics Board now requires all scheduled air carriers to have a flight recorder.

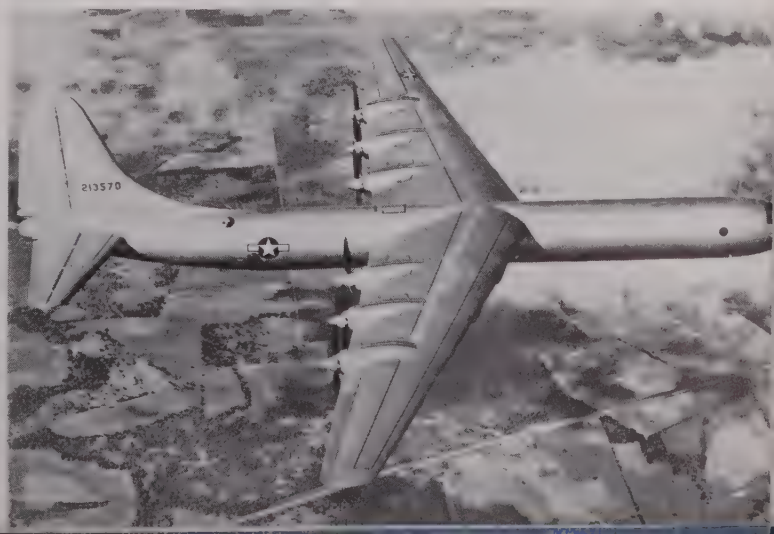
Communication . . . *For Private Flyers*

To enable the private flyer to talk to control towers and range stations at the frequency of 122 megacycles, where clear communication is experienced despite natural and man-made static, a small but effective VHF (very high frequency) transmitter was produced to operate in conjunction with the plane's existing radio. A small, yet efficient, whip antenna was made for use with the transmitters.

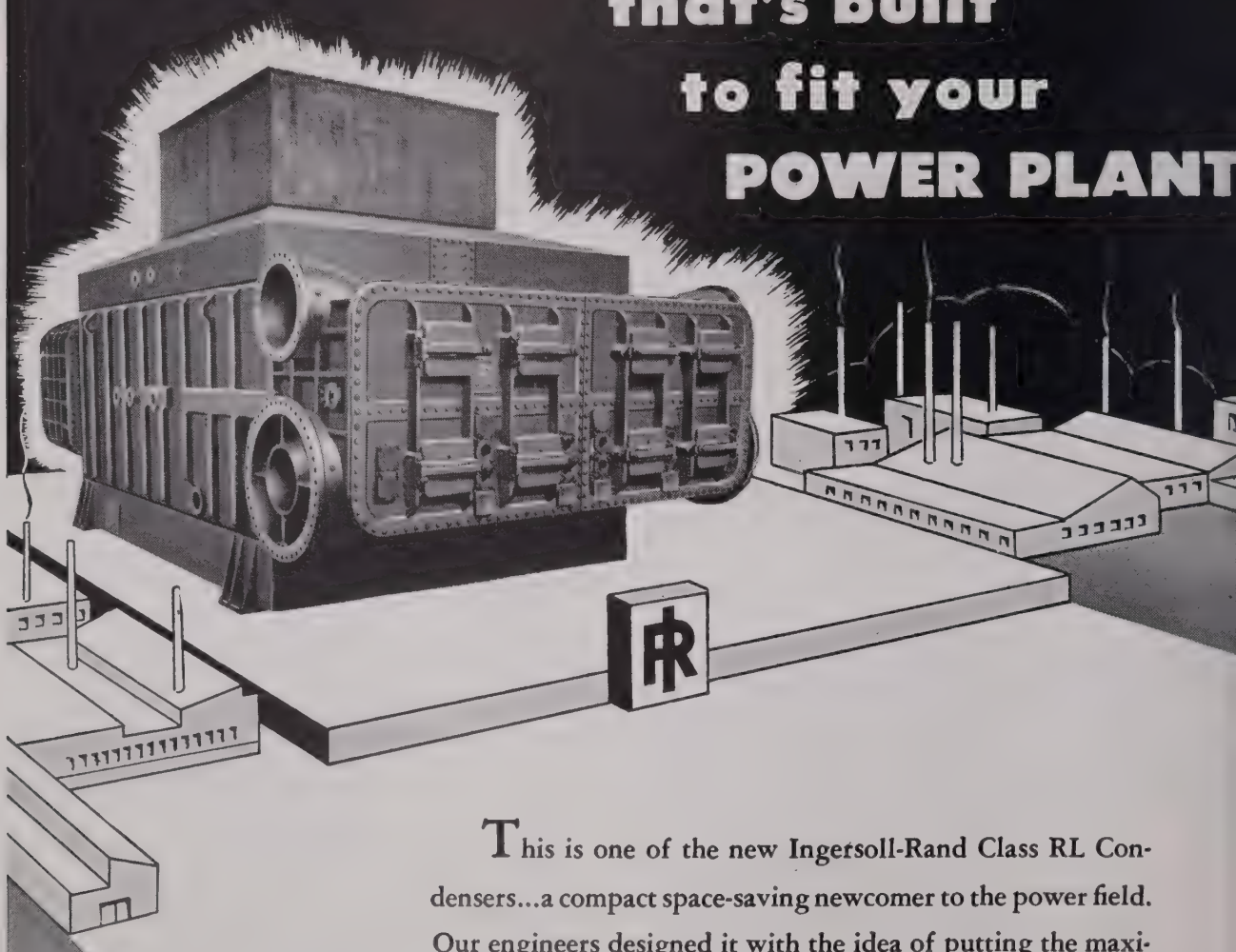
To enable pilots of personal planes to "home" on broadcast stations or to check bearings on radio ranges, a rotatable loop antenna was developed, to be connected to any standard aircraft radio receiver.

Previously there was a flying radio phone widely known for its 12 pounds, 12 tubes, 12 watts. A rearrangement of the same basic unit was developed for planes whose available space does not permit easy installation of the earlier model. With both models available, nearly all types of private aircraft may have installations.

Fig. 60. The Consolidated's B-36, the world's largest land-based bomber, features new armament



HERE'S A CONDENSER that's built to fit your POWER PLANT



This is one of the new Ingersoll-Rand Class RL Condensers...a compact space-saving newcomer to the power field. Our engineers designed it with the idea of putting the maximum condensing capacity into a minimum of space and produced the most compact condenser ever built.

The compactness of the RL means less foundation and lower headroom requirements. It means important savings in space and money. For full details call an Ingersoll-Rand Branch Office. One of our engineers will be glad to answer your questions.

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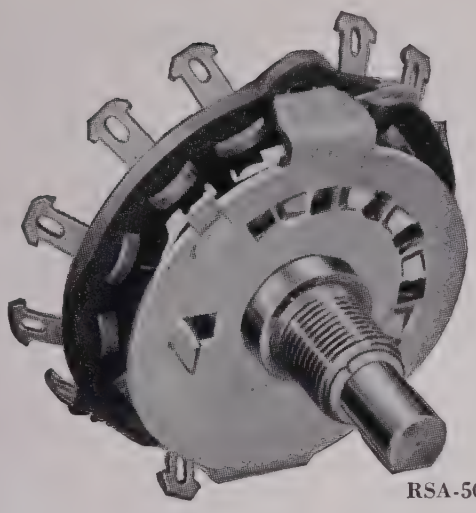
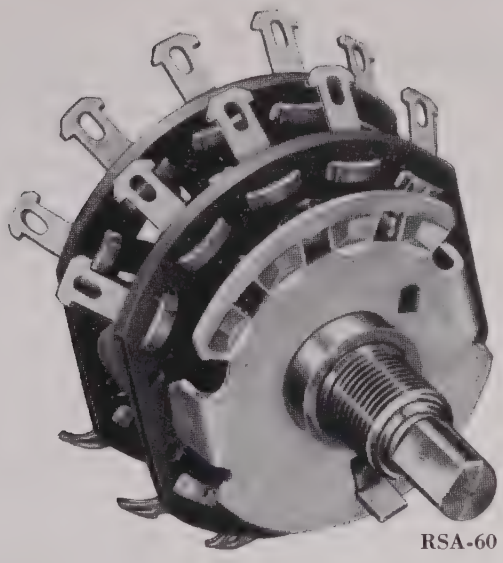
wo New Single or Double Section Switches . . .



RSA-50



RSA-60

. . of Space Saving Design and Mallory Precision Quality

. . . *Yet They Cost No More!*

Where space is a factor—dependability essential—*low cost a prerequisite*—the Mallory RSA-50 and RSA-60 switches fill the bill!

These *new* circuit selector switches, with section and terminal design identical to that of the famous Mallory RS-50 and RS-60 switches, are designed for band and tone control switching in radio receivers and other electronic applications where medium and low torque indexing action is desired.

The index assembly is of durable design and constructed with a minimum of parts—affording dependable service life with low torque and positive indexing action.

Note these many features, inherent in all the Mallory RS series, which contribute to the dependability and quality of these two new additions to the line:

- **Insulation of high-grade, low-loss laminated phenolic.**
- **Terminals and contacts of special Mallory spring alloy, heavily silver-plated to insure long life at low contact resistance.**
- **Terminals held securely by exclusive Mallory two-point fastening — heavy staples prevent loosening or twisting.**
- **Double wiping action on contacts with an inherent flexing feature—insures good electrical contact with the rotor shoes throughout rotation.**
- **Six rotor supports on the stator—insure accurate alignment.**
- **Brass rotor shoes, heavily silver-plated—insure low contact resistance.**
- **All shoes held flat and securely to phenolic rotor by rivets—prevents stubbing—insures smooth rotation—*minimum of noise in critical circuits.***

The RSA-50 and RSA-60 are both available in one or two section construction. The RSA-50 accommodates up to twelve terminals on either side of the section and provides from 2 to 6 positions. The RSA-60 accommodates up to ten terminals on either side of the section and provides from 2 to 5 positions. The RSA-60 has the narrow section design—ideal for under chassis mounting, where space saving is paramount.

ENGINEERING DATA SHEET

Send for the Mallory Engineering Data Sheet on the RSA-50 and RSA-60. It contains complete specifications for available circuit combinations with respective terminal locations, dimensional drawings—everything the engineer needs to adapt the RSA-50 or RSA-60 switch to a particular circuit.

SPECIFICATION SHEETS

Specification sheets for the RSA-50 and RSA-60 switches have also been prepared. These sheets are printed on thin paper to permit blueprinting. The sectional drawings indicate standard and optional dimensions—make it easy for you to order production samples built to your requirements.

P. R. MALLORY & CO. Inc.

MALLORY SWITCHES

(ELECTRONIC, INDUSTRIAL and APPLIANCE)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

HIGH LIGHTS AND SIDE LIGHTS

First Two-way Radio on Ferryboats

Installation of two-way FM radio equipment on four ferryboats and land locations of the Chesapeake Bay Ferry System, near Annapolis (Md.) enables the system, operated by the Maryland State Highway Commission, to become the first radio-equipped regularly scheduled ferry system in the nation.

FM transmitter-receiver sets have been installed in the wheelhouse of each ferryboat; the station headquarters units are located on the docks and in the State Highway Commission's office at Annapolis.

State Highway Commission officials expect that the system will: (1) enable dockmen to "talk the ferries in" in spite of fog and heavy storms which are prevalent in the area, especially in the fall and winter; (2) speed up docking and traffic throughout the main Bay channel; (3) facilitate many public service applications, such as the reporting of marine accidents, etc.

Installed by the U.S. Marine Technical Service at Baltimore in co-operation with engineers, the ferry communication system operates at a frequency of 43.02 mc. Mobile-type station units are located in the pilot house of each ferryboat. In the stern are remote-control units which operate the equipment over a pair of telephone lines. All units in the system are powered with the aid of 60-cycle a-c converters, operating from 100 volts d-c.

The land stations in the project utilize desk-type console 60-watt transmitter-receiver combinations. Remote-control units are also used in conjunction with this central station equipment.

The transmitter-receiver sets and central station equipment for the pioneer installation is standard FM two-way radio equipment, adapted by electronics engineers to fit its use in the marine system. It is expected that experience gained in this installation will furnish valuable information for other ferryboat systems in the country.

Titanium for Improving Fatigue Strength

From studies of alloying iron with certain other metals to improve the fatigue strength, titanium was found to be the most effective, according to a report to the American Society for Metals. The studies show that next to titanium those most effective are molybdenum, silicon, manganese, nickel, cobalt, and chromium.

The research showed that ultrasonic waves, when sent into the sample, may indicate the first minute crack which marks the true fatigue failure. At this time there is also a decrease in the rapidity with which the sample will vibrate when held at one end.

These studies are expected to aid in designing compositions of steels for constructional purposes having high fatigue strength.

Airport Lighting

A new high-intensity lighting system which under test enabled Army and Nav pilots to make consistently safe landing both day and night at ceiling zero, mad its debut at Charleston's $7 millio mountain-top Kanawha County Airpor following recent dedication ceremonies.

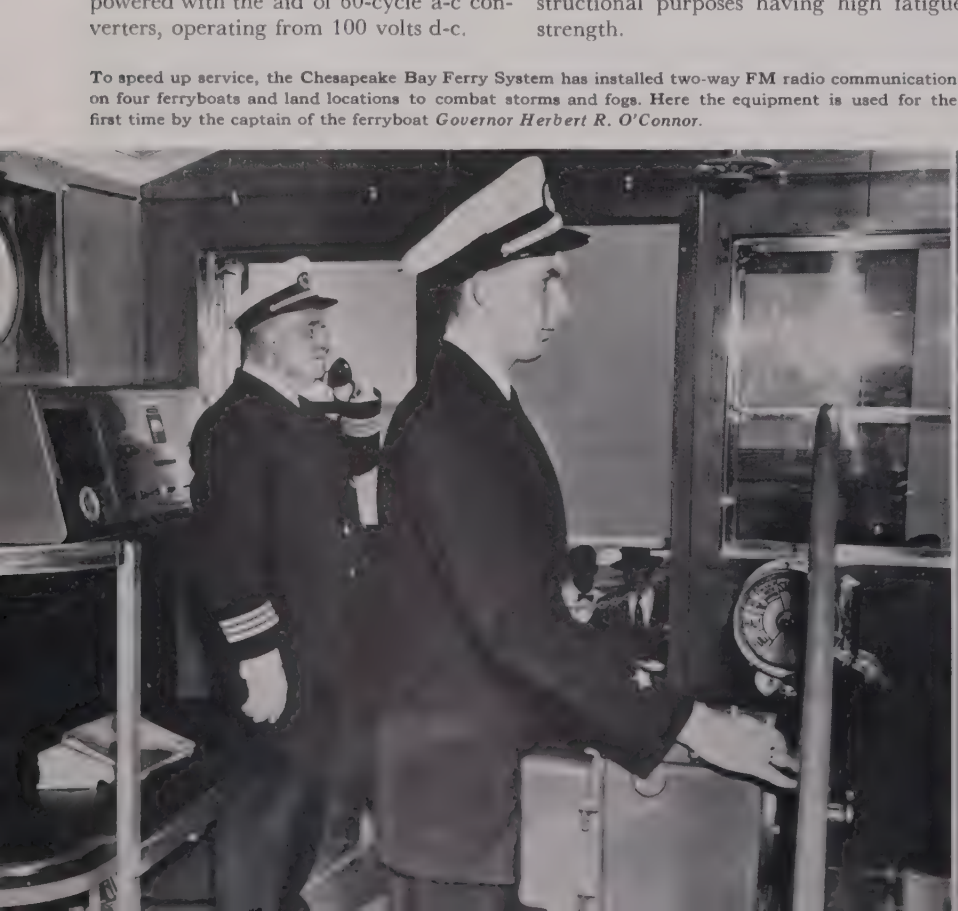
The system proved adequate for safe land ings with objects visible at only 400 ft whe tried during a daytime test at the Landin Aids Experiment Station, Arcata (Calif.)

Charleston's sixty new 44,000-cp unit can be seen from a distance of 1050 ft whe the daylight visibility of objects is limite to one eighth of a mile. The light in tensity can be varied by the contro tower from less than one per cent to 10 per cent. Thus, the proper intensity ca be selected to produce the range require for prevailing weather. Operations withou glare in all weather are accomplished b this variable-brightness control.

For runway safety, each light is mounte on a frangible coupling, which will brea off at ground level and fall out of the wa if struck by aircraft. The units, spaced a 200-ft intervals along the 5200-ft mai runway, include 12 threshold lights, 2 yellow runway lights, and 20 clear light Each weighs less than 12 lb and stand 18 in. from the ground.

The lights are of the elevated type rather than flush with the runway, be cause the light output required in ba weather can be attained only through th used of an elevated unit.

To speed up service, the Chesapeake Bay Ferry System has installed two-way FM radio communication on four ferryboats and land locations to combat storms and fogs. Here the equipment is used for the first time by the captain of the ferryboat *Governor Herbert R. O'Connor*.



A message is relayed to one of the Chesapeake Ba ferryboats from the toll house at Sandy Poi (Md.), where an FM transmitter-receiver is set u

Testing Switch Performance

Tiny electric switches can be operated at the rate of 2200 times a minute, or more than 3,000,000 times a day, by a machine recently developed to test the performance of such switches. With it, possible switch defects can be detected and analyzed for correction in future designs.

Seventy-two of the tiny electric switches, Switchettes, can be mounted on the machine at one time. As each switch is operated, its performance is indicated on a meter dial.

The Switchette was used extensively in electrical systems of military aircraft, more than 250 of them having been used in every B-29. Its use spread to many other wartime uses, and it has found a multitude of peacetime applications in machine shops, aircraft, vending machines, home appliances, and a variety of electric equipment.

Argon Gas for Hard-to-weld Metals

A new machine has been developed to weld such metals as aluminum, magnesium, stainless steels, copper alloys, Fernico, and Inconel.

The new welder is compact in one portable unit. It is possible to weld the "difficult" metals because the electric arc works within an atmosphere of argon gas; this atmosphere reduces oxidation during welding.

Inert-atmosphere arc welding is unique in being capable of making clean, sound welds in these metals without the use of corrosive fluxes. Many assemblies require this method of welding because of the difficulty of removing the fluxes that are necessary with other methods.

Another feature of this machine is that it does not cause undue radio interference while in operation. A pilot-spark circuit, which operates for only a fraction of a second during the starting of the arc, eliminates the likelihood of objectionable interference.

Quickening Production of Fractional-horsepower Motors

A close study of materials and methods used in the manufacture of fractional-horsepower motors and generators is resulting in new manufacturing techniques which are quickening production.

One innovation now in use is a means of assembling permanent magnets in rotating machines without the need of grinding the pole faces, heretofore a costly and time-consuming process. After being cast as close to size and shape as possible, the magnet is assembled between soft steel parts that can be machined to maintain over-all dimensions. The air gaps between the steel parts and the cast permanent-magnet surfaces are filled with iron powder and a supporting cement. A thermal-setting cement is used as a carrier for the iron powder and is not intended to provide mechanical support for the pole faces.

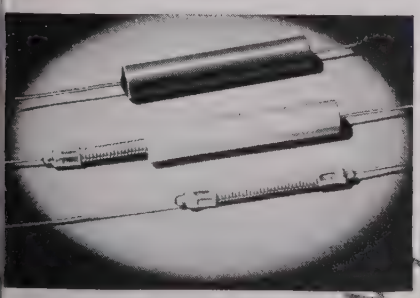
This construction is being used on several fractional-horsepower permanent-magnet d-c generator stators and may soon be applied on alternators having rotors of similar construction.

Microwave Relay for Television

Rapid expansion of the microwave radio method of relaying television programs is being predicted by officials. At present three privately owned microwave television relays are being operated by broadcasters: one between New York City and Schenectady; another between South Bend and Chicago; and a third between New York and Philadelphia.

Many television stations are expected to enlarge their audiences by this method in 1948. Areas within 300 miles of the nation's major television centers could be served by these relays, using equipment already developed and proved in service.

It has been pointed out that microwave relays offer the quickest and most economical way for expanding the television audience.



Wire winding on fibre-glass core.

☆

Axial bare pigtail leads clinched to ends.

☆

Ceramic tube filled and sealed with cold-setting inorganic cement. No blistering, cracking, bulging.

☆

Type C7GJ, 1¾" x 5/16", 7 watts, 5000 ohms max. Type C4GJ, 1" x 5/16", 4 watts, 1000 ohms max.

and now the GREENOHM JR.

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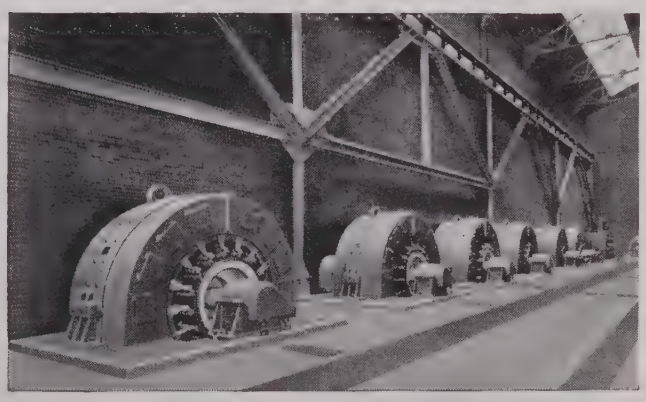

Five 3500 hp and one 3000 hp D-C Motors manufactured at the Peterborough Works of Canadian General Electric driving main rolls on a 56 inch continuous strip mill at The Steel Co. of Canada Ltd., Hamilton, Ont.

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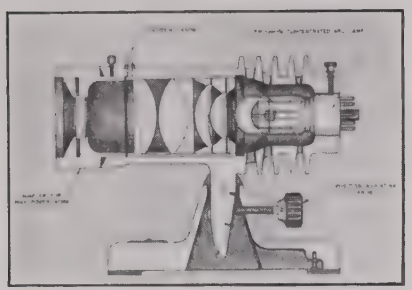
NEW PRODUCTS: AND WHAT THEIR MAKERS HAVE TO SAY ABOUT THEM

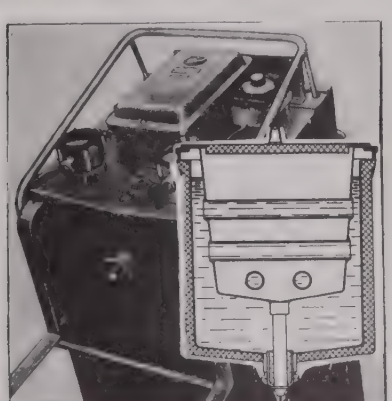
Photomicrographic Lamp



A new lamp, known as the Zirconarc, for better results in photomicrography, microscopy, macrophotography, and microprojection, uses a 40-watt Zirconium bulb. Actually an arc lamp, but with the electrodes fixed and sealed within a glass bulb containing an inert atmosphere, it is called a "concentrated-arc" lamp because the activity is concentrated upon a very small portion of the electrode. This produces a high-intensity light source in the form of a luminous circular spot only 0.037 in. in diameter, having characteristics well-suited for optical systems. The condenser system collects a full 100-deg cone of light from the light source and the system is corrected for spherical aberration, coma, and color. The optical corrections are of a high order.—*Fish Schurman Corp., 230 E. 45th St., New York 17, N.Y.*

Dispensing Tanks

Two new indirectly heated, thermostatically controlled, melting and dispensing tanks with indirectly heated dispensing valves are built on the double-boiler principle. These units eliminate over 90 per cent of the causes for production stop-



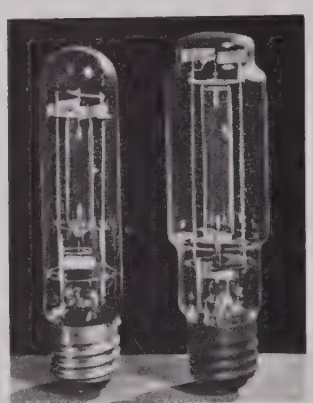
pages in melting and dispensing battery and transformer compounds, critical waxes, and similar materials. Because the heat comes into the compound uniformly at the same controlled temperature from every square inch of contact with the inner surface of the vat in the double-boiler arrangement, the material being heated does not "coke" or char. Both gas-fired and electrically heated units are available.—*Aeroil Products Co., Inc., 57th St. and Park Ave., West New York, N.J.*

Conduit Clamp

A new conduit clamp facilitates installation. The clamp snaps on the conduit and stays in place, leaving the workman free to use both hands for the placing and fastening of the conduit to the wall or ceiling. The clamps are cold-pressed from 0.062-in. steel stock with dual reinforcing ribs. Cadmium plating adds to the appearance of the finished job.—*Industrial Devices, Inc., 22 State Rd., Edgewater, N. J.*

Mercury Lamp

A new A-H5 mercury lamp of improved design for black-light installations, for street lighting, and for all other general lighting applications in which mercury lamps are particularly desirable. Although the new lamp is used with a transformer, it can be applied in all presently existing equipment, as there is no change required in auxiliary or fixture dimensions. The new lamps, shown at the right of the illustration,



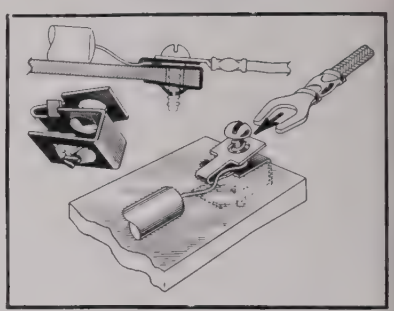
looks slightly different from the former model because of changes made in the outer bulb structure. Also, the inner arc tube has been redesigned to produce greater efficiency, longer life, and to permit burning in any position. This lamp is rated 250 watts and has a maximum outside length of 8 in.—*General Electric Co., Lamp Dept., Nela Park, Cleveland, Ohio.*

Car Unloading Team

Two new units—the 358 heavy-duty car unloader and the 363 portable stockpiler-loader—facilitate the unloading of stone, sand, gravel, etc., from hopper cars. This equipment works equally well as a "team" or individually for all classes of users—from road contractors and build-

ing material yards to foundries and industrial plants. Among the features of the unloader is the chain and belt conveyor. Power is transmitted through chain and belt which are riveted together by means of steel attachments and cleats to give positive belt movement. The stair-channel frame of the stockpiler-loader is strong and rigid. An added advantage is the flexibility afforded by the simple swiveling wheels.—*Barber-Greene Co., Aurora, Illinois.*

Fastener



A new fastener of the speed-nut type for use on electrical terminal boards t facilitate the interconnecting of capaci tors and resistors. In assembly, the "U shape of the nut slips over the termina board and holds itself over the clearanc hole. A screw is then partially run dow through the nut and board to anchor wire in place, one at a time, under the nu until all are attached, after which th screw is completely tightened. With thi arrangement any of the leads can b removed without disturbing the others This nut also can advantageously be use for leads with a spade terminal or fo single-strand pigtails from capacitors an resistors.—*Tinnerman Products, Inc 2186 Fulton Rd., Cleveland 13, Ohio.*

High-frequency Converter

A new 20-kw high-frequency spark gap-type converter for induction heatin and melting features simple controls safety interlocks, and streamlined hous ing. Only one control knob is needed t

adjust the converter to the proper powe output when connected to a metallurgica furnace or heating coil. The electrical cir cuit is self-tuning, with frequencies vary ing from 20,000 to 80,000 cps, dependin on the type of furnace coil to which it connected. Specially tipped copper elec trodes equip the hydrogen-atmospher water-cooled spark-gap chamber.—*Aja Electrothermic Corp., Ajax Park, Trenta 5, N. J.*

Resistors

A compact 5-watt resistor has bee added to the Brown Devil line of 10- an 20-watt vitreous enamelled wire-woun resistors for radio, electronic, and i dustrial circuits. The resistance valu

(Continued on next left-hand pag

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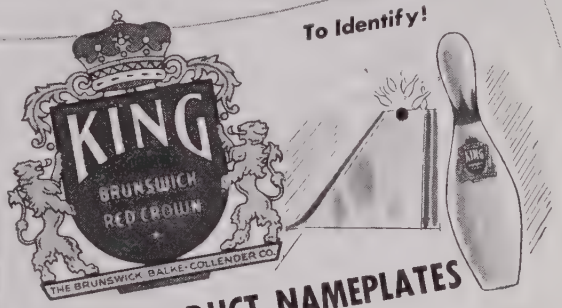

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Here's proof of durability! Despite the battering punishment bowlers deliver the Brunswick-Balke-Collender trademark, it provides durable, lasting and colorful identification. New application techniques developed by Meyercord permit quick, lasting adhesion of Decal nameplates at high production line speeds.

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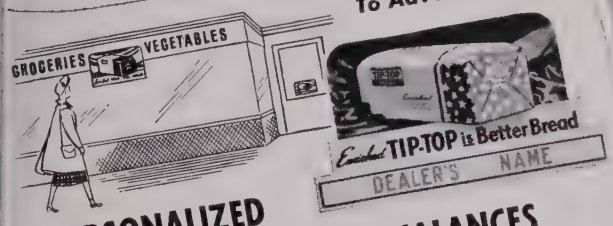

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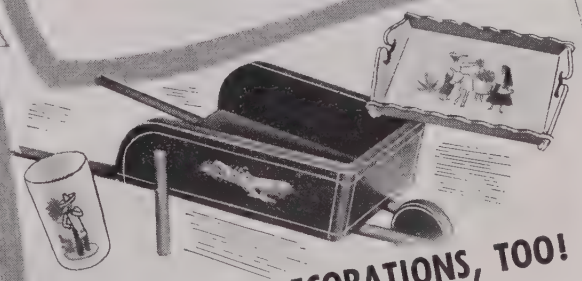

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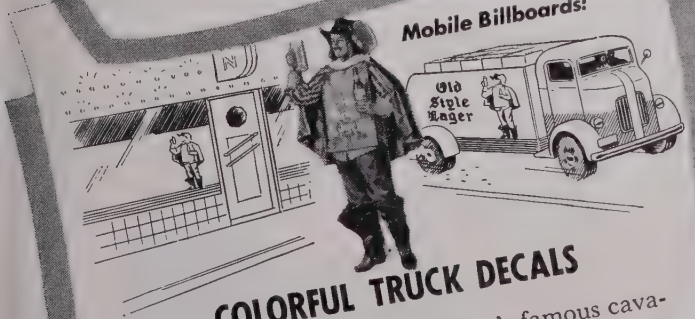

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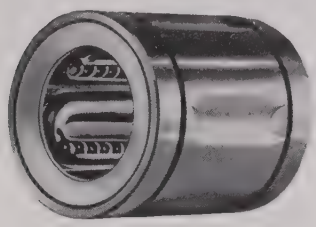
are from 1 to 10,000 ohms. Standard tolerance is ±10 per cent. These resistors are of all-welded construction equipped with ½-in. copper wire leads.—*Ohmite Manufacturing Co., 4952 Flournoy St., Chicago.*

Linear Ball Bearing



A new type of unlimited travel antifriction bearings, called Series A ball bushing, for linear or reciprocating motion. The bearing is a self-contained unit and has three basic parts in addition to the balls: first, a sleeve made of 52100 ball-bearing steel, hardened and ground to close tolerances; second, a pressed-steel retainer which is fabricated in long continuous strips, cut off and rolled up to fit inside the sleeve; and third, a pair of rings which are pressed in the ends of the sleeve to position and secure the retainer to the sleeve. This bearing has a low friction coefficient which prevents cocking and binding, and its free-rolling action maintains precision alignment by elimination of wear.—*Thomson Industries, Inc., 1029 Plandome Rd., Manhasset, N. Y.*

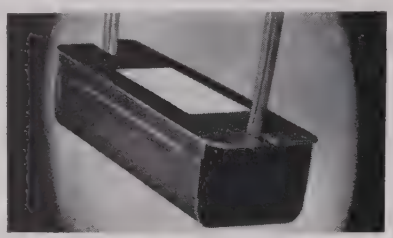
Fuse Resistors

A new wire-wound resistor, Type OWA, performs two functions: first, that of a resistor and, second, that of a fuse. The difference between the two functions is one of power level. At a relatively low level, the unit functions as an ordinary resistor; at a higher power level, it functions as a fuse and "open circuits" when the wire burns out.

This resistor is custom designed to individual circuit requirements and is available in RMA values from 15 to 150 ohms. Power rating is one watt.—*International Resistance Co., Philadelphia, Pa.*

Fluorescent Lamp Ballasts

Two new groups of ballasts for Slimline fluorescent lamps, available in both single-lamp and Tulamp high-power-factor designs, operate at current values of 120 and 300 ma. For operation of cold-cathode lamps, the ballasts are enclosed in a brick-type case and are designed to operate the 72T8 and the 96T8 lamps at 120 ma. The complete line of Slimline ballasts now in-



cludes those for 120-, 200-, and 300-ma operation of 42T6, 64T6, 72T8, and 96T8 lamps. Because difference in light output of these lamps is roughly proportional difference in lamp current, three distir light levels are obtainable for each lamp. *General Electric Co., Specialty Transforn and Ballast Divisions, Schenectady 5, N.*

Photoflash Transformer

A new series of transformers, PF PF-2, and PF-3, designed especially photoflash use. The series includes transformer for use from 110-volt lin one for battery-powered application, a a "trigger" transformer to be used conjunction with either of the others.

The PF-1 transformer has a 110-v primary, a secondary which provides to 2200 volts d-c (after rectification) the condenser, and a filament winding the required 2 X 2 rectifier tube. The PF transformer primary is tapped for 4- 6-volt battery operation with full-wa vibrator. The secondary has the sa 2200-volt rating for condensers up to mfd. The PF-3 trigger transformer livers a 15-kv peak and is used to cont the firing of the flash tube. It derives voltage as a pulse from the d-c netwo —*United Transformer Corp., 150 Var St., New York 13, N. Y.*

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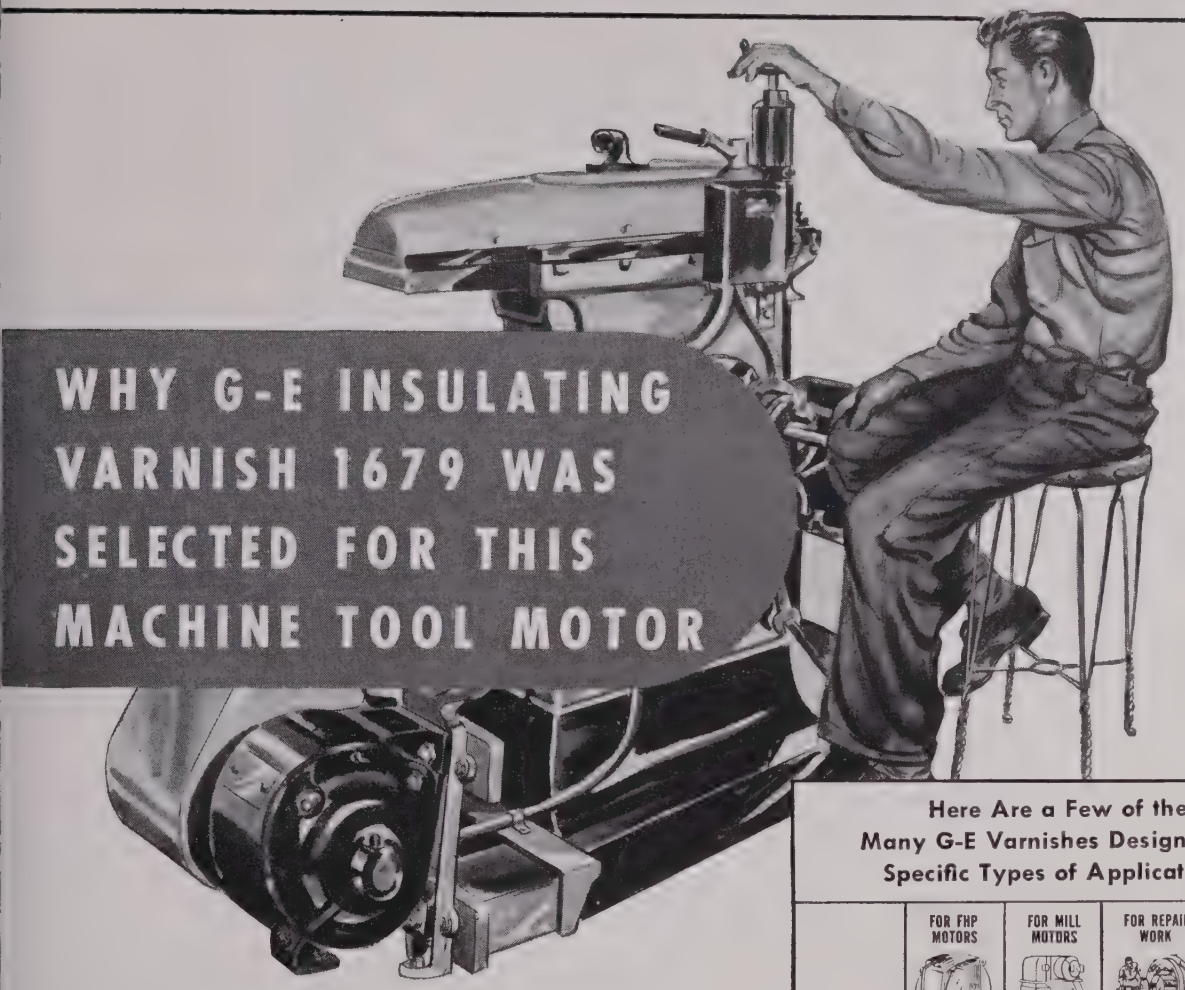

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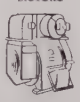
	FOR FHP MOTORS G-E 9535	FOR MILL MOTORS  G-E 9555	FOR REPAIR WORK G-E 9574	FOR POWER DISTRIBUTION APPARATUS G-E 1673
BOND	GOOD	GOOD	EXCELLENT	GOOD
DIELECTRIC STRENGTH	EXCELLENT	GOOD	GOOD	GOOD
RESISTANCE TO MOISTURE	EXCELLENT	EXCELLENT	EXCELLENT	GOOD
RESISTANCE TO ALKALI	GOOD	EXCELLENT	EXCELLENT	FAIR
RESISTANCE TO ACIDS	EXCELLENT	EXCELLENT	EXCELLENT	GOOD
RESISTANCE TO SALT WATER	EXCELLENT	EXCELLENT	EXCELLENT	GOOD
PENETRATION	EXCELLENT	EXCELLENT	GOOD	EXCELLENT
TOUGHNESS	EXCELLENT	EXCELLENT	EXCELLENT	GOOD
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A-c Contactors—Application, construction, and operating coils are some of the subjects given in this pamphlet on solenoid contactors. A dimension drawing and a rating chart are included. Four pages. Bulletin 4451.—*Ward Leonard Electric Co., 31 South Street, Mount Vernon, N. Y.*

Adjustable Air Diffusers—Of interest to architects, engineers, and constructors. Many illustrations, numerous design and operating charts, cross-section drawings, and text material are presented and cover such subjects as performance, selection and location of the unit, testing and balancing, and air-direction and air-volume adjustment. Thirty-two pages. Bulletin R-20. *W. B. Conner Engineering Corp., 114 East 32 Street, New York 16, N. Y.*

Boring Tools—A number of typical boring applications are illustrated, and the performance is shown through a comprehensive sequence of operations. A full range of boring-head sizes is given. Six pages. Form No. 117A-947-S—*Kaukauna Machine Corp. Kaukauna, Wis.*

Ceramic Materials—Presented in textbook form, the technical literature on special ceramic materials is divided into three main sections: improved ceramic dielectric materials for electrical or electronic purposes; improved stoneware, as used for chemical engineering purposes; and chemical procelain for industrial purposes. Production and manufacturing processes and general information on composition, physical properties, and application in different fields of engineering are included, along with many circuit diagrams, schematics, and tables. Thirty-two pages. Entitled, "Special Ceramic Materials and Their Industrial Applications."—*General Ceramics and Steatite Corporation, Keasby, N. J.*

Diesel Engines—Description of turbocharged engines, built in three sizes: six cylinder, 675 hp; seven cylinder, 785 hp; and eight cylinder, 900 hp. Horsepower ratings, fuel-consumption curves, and features and improvements are presented, in addition to a comparison of space requirements of these engines to unsupercharged engines. Four pages. Form 10311.—*Ingersoll-Rand, 11 Broadway, New York 4, N. Y.*

Flow Measurement—Used to measure the flow of liquids and gases, this variable-area-type flow meter is described and illustrated with photographs, cross-sectional diagrams, and many charts and drawings which contrast its performance to that of an orifice-type meter. Entitled "A New Era in Liquid and Gas Flow Measurement," the booklet discusses such topics as: basic principles; linear-flow characteristics; and immunity of calibration to variations in fluid viscosity. Thirty-two pages. *Catalog Section 10-D.—Fischer and Porter Co., Dept. 7F-F, Hatboro, Pa.*

High-voltage Resistors—Specifications and characteristics for resistors from two to ninety watts in eight terminal types. A section of this technical-data bulletin concerns installation, and topics briefly covered under this subject are: handling; mounting; cooling to increase power rating; and variations available. Four pages. Bulletin G-1.—*International Resistance Company, 401 N. Broad St., Philadelphia, Pa.*

Hole-punching Equipment—For punching holes in sheets, angles, and extrusions. Several types developed for special applications are illustrated and described. Installation photographs and lettered cross-section drawings are used in the explanation of the operation and application. Sixteen pages. Catalog C.—*Wales Strippet Corp., North Tonawanda, N. Y.*

Induction Furnaces—Twenty- and forty-kilowatt spark-gap converters used for a wide variety of induction melting, heating, brazing, and hardening applications are described. Advantages, principles of operation, specifications, and performance data are included. Sixteen pages. Bulletin 14-A.—*Ajax Electrothermic Corporation, Ajax Park, Trenton 5, N. J.*

Photographic Paper—Paper designed to produce high-contrast positive copy from a positive original in normal room illumination with standard blueprint or direct-process printers. The booklet describes the use of the paper for such problems as reproducing opaque drawings, worn, stained or discolored tracings, or direct-process prints or blueprints. Eight pages. Entitled "The Big New Plus."—*Eastman Kodak Co., Industrial Photograph Div., 343 State St., Rochester 4, N. Y.*

Precision Products—A condensed catalog of products, services, and gear-manufacturing facilities. Descriptions and illustrations cover such subjects as gears, speed reducers, couplings, high-speed drives, and marine drives. Available services include steel casting and machining weldments. Twelve pages. Bulletin 10,000—*The Falk Corp., 3001 West Canal St., Milwaukee, Wis.*

Resistance-welding Controls—Nonsynchronous controls are described with internal arrangements of parts and wiring illustrated. Comments pertain to accuracy, maintenance, and installation and a list of eleven features is included. Four pages. *Control Bulletin 10-213.—The Taylor-Winfield Corporation, Warren, Ohio.*

Temperature Monitor—For automatic temperature checking. Circuit diagrams are given to aid the explanation of operation, in addition to cross-section diagrams and photographs of elements. Twelve pages. Entitled "Critical Temperature Monitor."—*Thomas A. Edison, Inc., Instrument Division, West Orange, N. J.*

Wood Preservative—The nature of penta-chlorphenol, and why unique wood preserving advantages are contained. Application of modern chemistry for wood preservation is outlined in this colorful booklet. Sixteen pages. Entitled "Penta Preservative."—*Chapman Chemical Co., Suite 544, 333 North Michigan Ave., Chicago 1, Ill.*

X-ray Diffraction—Information for those actively engaged in fiber research concerning an x-ray diffraction camera for micro-techniques especially adapted to fiber analysis is contained in this reprint from The Review of Scientific Instruments. Construction, application, and operation is explained in text form. The folder is illustrated with photographs and drawings. Sample diffraction patterns are given for unstretched polyethylene and stretched polyethylene. Three pages. Release A-30422.—*North America Phillips Co., Inc., 100 East 42nd St., New York 17, N. Y.*

BOOK REVIEWS

(Available books may be purchased through the GENERAL ELECTRIC REVIEW for domestic delivery; none sent on approval.)

lements of Electrical Engineering.

rthur L. Cook and Clifford C. Carr—
52 pp., 1947. John Wiley and Sons, Inc.,
ew York. $5.00.

This is the fifth edition of a text book
iat has been widely used for more than
) years by college students. The subject
iatter provides a broad coverage of the
indamentals of electrical engineering.

The first part of the book is devoted
) a comprehensive review of the funda-
ientals of electricity and magnetism.
ther sections cover D-c Machinery,
lternating Currents, A-c Machinery and
nstruments, Electronics, and Special
pplications. The authors have presented
ie text material in a clear and logical man-
er, with emphasis on basic principles.
ists of questions and problems associ-
ted with each chapter are used to help
ccomplish this objective.

This edition is thoroughly up to date.
he chapters on d-c and a-c machinery
ave been expanded to include new types
f apparatus and new methods of control.
he authors have also done a very good
)b of concisely presenting fundamentals
nd characteristics of electron tubes, elec-
onic circuits, and the application of
ectronic devices.

B. A. CASE

able of the Bessel Functions $J_0(z)$ and $J_1(z)$ for Complex Arguments. (Second dition)

repared by the Mathematical Tables Proj-
ct, National Bureau of Standards—408
p. 1947. Columbia University Press, New
ork. $7.50.

The importance and widespread use of
iese tables can be judged from the fact
iat after four brief years a second edition
as become necessary. The tables list ten-
ecimal-place values of the Bessel functions
$_0$ and J_1 for complex arguments $z=\rho e^{j\phi}$,
here ρ increases in 0.01 steps from 0 to 10,
nd ϕ increases in 5° steps from 0° to 90°.
he functions $\phi=0$ (Bessel functions of real
rgument), $\phi=90°$ (I functions), and $\phi=$
35° (ber and bei functions, reducible to the
$=45°$ case) are of particular importance
n many technical applications. Functions
f other ϕ angles have also attracted atten-
on in recent years.

Once the J_0 and J_1 functions are known
or a certain argument, the J_n (nth order
inction) and J_n' (nth order derivative
inction) are readily obtained from well-
nown recurrence formulas. Hence the
ables, in a way, furnish the values of all
ntegral ordered Bessel functions and their
erivatives. In practice, since the higher
$_n$ are obtained by differencing lower ones,
ventual loss of significant digits prevents
ne from carrying the recurrence relations
o too high an n when ρ is large.

A companion volume, giving the values
f Y_0 and Y_1, "the functions of the second
ind," is now in preparation.

The low quality of the paper on which
he tables are printed should not detract
om their value and usefulness.

G. HORVAY

Jltrahigh-frequency Transmission and Radiation.

Jathan Marchand—322 pp. 1947. John
Viley and Sons, Inc., New York. $4.50.

This book, according to the author, is
ntended to be of value to college students
s well as practising engineers. As a result
it contains a mixture of simple engineering theory and the mathematical theory of wave propagation. For example, the first chapter contains an elementary account of transmission-line theory from an engineering point of view. Then vector analysis, as a mathematical tool, is introduced and used sparingly in a general treatment of Maxwell's equations. The theory of radiation from an antenna is dealt with by the use of the vector potential—although this name is not emphasized, presumably to keep from discouraging the reader. Wave guides are then analyzed; and, in the last chapter, the use of equivalent circuits in treating discontinuities in wave guides and transmission lines is described.

Part of the material has stood the test of use at Columbia University, and to those for whom it was intended it can be recommended as giving an introduction to a complex subject in as easy a manner as would seem possible.

W. C. HAHN

Phenoplasts: Their Structure, Properties and Chemical Technology. (Volume VII in a series entitled High Polymers.)

T. S. Carswell—267 pp. 1947. Interscience Publishers, Inc., New York. $5.50.

The purpose of this book, as stated by the author in the preface, is "to describe, as accurately as the present information will permit, the physical and chemical structure of the phenoplasts, and to correlate their structure with their mechanical and chemical properties." The author and his associates are to be commended for attaining his objective in a very clearly written and readable book.

In the first few chapters the author has woven the presentation of the various theories and facts into a thought-provoking picture that will give many readers new ideas on work to be done to either prove or disprove the controversial theories. The chapters on mechanical properties are a ready reference for data on actual values as well as the influences which temperature, resin content, and degree of cure have on these values.

It is to be regretted that a book of this caliber should use the archaic nomenclature for xylenols (e.g., *m*-5-xylenol in Tables I, V, and VI) and the modern nomenclature (e.g., 3, 5-xylenol in Table III) rather than maintaining a consistent nomenclature governed by modern usage and acceptance. Errors in tabular data which do not support the accompanying text, as illustrated by the incorrect range for impact strength of cotton-flock-filled materials on page 86, occur occasionally. These errors will provoke the careful reader and cause him to wonder whether the book may have been too hastily written and not thoroughly enough proofread by a competent reader. In spite of these faults, this book fills a need for a reference book which brings together in one volume all the important published material on phenoplasts.

J. W. UNDERWOOD

Practical Descriptive Geometry.

S. E. Rusinoff, M.E.—259 pp. 1947. American Technical Society, Chicago. $3.50.

Samuel E. Rusinoff's industrial and teaching experience has qualified him as an author of a truly practical book of descriptive geometry. It deals with practical application of the principles of descriptive geometry to problems encountered in the shop, drafting room, and general engineering work.

The book shows how descriptive geometry is applied in the automotive, machine-tool, aviation, and steel industries and in generally related fields.

Simplicity and clarity are the conspicuous qualities of this book, which strongly recommend its use in industry as well as in the classroom.

The first two chapters present a condensed review of engineering drafting and the application of basic principles of geometry and drafting. The principles of projection are clearly explained. Emphasis is placed on the correlation of orthographic drawing and descriptive geometry as they relate to problems arising on the job. Subsequent chapters apply the principles of descriptive geometry in the designing and the assembling of machines and parts. The introduction of a principle is followed by its application to an industrial problem.

RANDALL K. LEPPER

Fluorescent Lighting Manual. (Second Edition)

Charles L. Amick—318 pp. 1947. McGraw-Hill Book Co., Inc., New York. $4.00.

In the words of the preface, the purpose of this book is "to provide a ready reference source giving the various types of information necessary to design, sell, install, and

(Continued on next page)

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service fluorescent lighting systems." It is an eminently practical book, confining itself to factual information so chosen as to cover comprehensively the many aspects involved in the successful use of this novel and popular illuminant.

The opening chapter deals with the lamp itself—its construction, the correlation between the phosphors and the discharge, and its electrical and luminous characteristics. Two later chapters deal more specifically with operating characteristics and with details of color quality.

The operation of the lamp is amplified in two further chapters written from the viewpoint of the illuminating engineer. Specific information is given on the proper design of installations for a variety of applications. Another chapter describes the computation of cost of installations, including a detailed comparison of fluorescent and incandescent systems.

The remaining chapters deal with features involved in the use of the lamp, such as auxiliary equipment, luminaires, and recommendations for installing and servicing.

The value of the book is greatly enhanced by the large number of figures and tables over two hundred of the former, mostly diagrams, and over fifty of the latter. Most of the diagrams in the present edition have been extended to present information made available during the past five years, and many of the tables have been amplified.

GORTON R. FONDA

Circuits and Machines in Electrical Engineering. Two Volumes. (Second Edition) John O. Kraehenbuehl and Max A. Faucett —370 pp. each volume. 1947. John Wiley and Sons, Inc., New York. $4.25 each.

Volume I—Circuits

The text of this book is written for students having no previous training in electrical engineering. Much space is therefore devoted to description of the basic physical concepts and comparison with the analogous mechanical systems. The student is constantly reminded of these fundamental relationships as he progresses through the book.

The author sidesteps the question of units by using "the cgs concept in basic discussions" (because of the student's background in physics) and practical English units for most of the text, although he feels that "the MKS system would give an ideal solution to the confusion of units."

The main body of the text is conventional. The development of circuits and network analysis proceeds in a careful and systematic manner. D-c and single-phase a-c circuits are considered simultaneously. The section on polyphase circuits is followed by a chapter on power distribution from a practical point of view.

The volume is concluded with a brief general treatment of electronic tubes and circuits and a few pages on meters.

The book deals with the transition from college physics to the study of electrical engineering. As such, it necessarily touches many subjects briefly, few completely. It is well written, but limited to an introductory role.

Volume II—Machines

The introductory chapters of the second volume are typical of basic machine texts, dealing with physical construction and magnetic-circuit properties. Following these, a chapter on magnetomotive force takes up the fundamental concepts relating electric circuits and magnetic fields in machines. Here simple examples and illustrations introduce rotating fields, armature reaction, and leakage reactance. Both a-c and d-c cases are presented.

Successive chapters on transformers, generated voltages, and commutation complete the portion of the book devoted to generalized machine concepts. The subject matter, as well as the arrangement, is designed to keep d-c and a-c machines on the same basis as far as possible.

Getting down to specific machines, the author finds it desirable to separate them as a-c generators, a-c motors, d-c generators, and d-c motors. Each section is treated in a straightforward, but necessarily brief, manner.

The remainder of the book again groups all machines together and covers efficiency and losses, parallel operation, and special applications.

The final chapter changes the subject completely to deal with electrical illumination.

The book provides a good introduction to the concepts of machine operation. The treatment of specific machines is necessarily rather superficial, since an attempt is made to cover a great deal of ground in a few chapters.

D. B. WHEELER

Proceedings of the National Electronics Conference, Volume II.

741 pp. 1947. National Electronics Conference, Inc., Northwestern University, Evanston (Ill.). $3.50.

When the first National Electronics Conference—sponsored by Northwestern University, Illinois Institute of Technology, and the University of Illinois and the local sections of the A. I. E. E. and the I. R. E.—was held in Chicago in October, 1944, an opportunity, limited by wartime secrecy still in force, was afforded for presentation of papers about many new developments in the electronic field. When the second Conference was held two years later, the need for secrecy had been greatly relaxed and the 2300 registrants heard 64 papers covering numerous aspects of the field.

In this Volume II of the Proceedings of the conference, most of the papers given in 1946 are published. A few of the articles, like those by Dr. E. U. Condon, director of the National Bureau of Standards, and Dr. C. G. Suits, director of the G-E Research Laboratory, are general in character, but the majority deal with specific equipments and techniques, such as electronic d-c motor drives, Teleran and other systems of electronic navigation, use of microwaves in industrial heating, color television, nuclear research with 100,000,000-volt x-rays, industrial applications of the mass spectrometer, slot antennas, military applications of infrared, etc. Those who attended the meeting will find the book of great use to refresh their memory, and to others who were not there it will be equally valuable, in summarizing so many facets of the electronics art in 1946. They will look forward eagerly to Volume III, reporting the conference held in November, 1947.

JAMES STOKLEY

Foley's College Physics. (Fourth Edition) Revised by J. L. Glathart—703 pp. 1947. Blakiston Co., Philadelphia. $4.25.

In the revision by Dr. Glathart of this well-known college text, the most notable feature is the inclusion of brief chapters on Nuclear Physics and Atomic Energy. A quotation several pages long from the official War Department release on the New Mexico test of the atom bomb serves as the introduction to the book.

Aside from the addition of material on atomic physics, the changes consist mainly of rearrangements in the old text, which are good or bad according to the preference of the particular instructor who is using it. A good feature is the inclusion, at appropriate points in the text, of illustrative numerical examples *with solutions*. This should prove particularly helpful to the student beginning liberal-arts physics, and it is for these students that the text is primarily intended. All problems have been placed in a separate section at the end of the book, an arrangement which will doubtless meet with the approval of some and the annoyance of others. The student will find helpful the plan of presenting pairs of similar problems and giving the answer to the first one of each pair.

For a general course in physics, where the use of mathematics is somewhat restricted and calculus is avoided, *Foley's College Physics* has proved itself a very good text, and with the new edition the good record should continue.

FRANK J. STUDER

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ON ARTICLES IN OTHER TECHNICAL JOURNALS

ALLOYS, MAGNETIC

Ten New Magnetic Materials in Review.

Alex E. Javitz—*Elec. Mfg.*, Sept., 1947; v. 40, pp. 74-78, 194, etc.

The properties and applications of several magnetic alloys supplementing the alnico group.

ATOMIC POWER

Fifty Years of Atomic Research.

S. C. Lind—*Chem. & Engng. News*, Sept. 1, 1947; v. 25, pp. 2495-2499.

An unbroken chain of developments, started by the discovery of X-rays in 1895 by Roentgen, which culminated in the discovery of nuclear fission. A Remsen Memorial Lecture by the Dean, Institute of Technology, University of Minnesota.

Research in Germany on the Technical Application of Atomic Energy.

Werner Heisenberg—*Chem. & Engng. News*, Sept. 15, 1947; v. 25, pp. 2620-2623.

Wartime German atomic energy research, directed toward development of a prime mover rather than explosive use.

The Story of Atomic Energy.

Frederick Soddy— *Engng.*, Oct. 3, 1947; v. 164, pp. 313-317.

The first installment of a serial article which traces the story from the days of alchemy to the present time.

AVIATION—INSTRUMENTS

Automatic Flight.

James L. Anast—*Mach. Design*, Sept., 1947; v. 19, pp. 116-120, 186.

Airplane instruments and control equipment.

BRAZING

Low Temperature Silver Alloy Brazing.

Steel, Sept. 8, 1947; v. 121, pp. 76-77, 108, 110.

Description of several production techniques used with this method of joining.

CALCULATING INSTRUMENTS

Computer for Principal Stresses.

R. G. Manley—*Engng.*, Oct. 10, 1947; v. 164, pp. 340-341.

To facilitate the evaluation of principal surface stresses from observed strain data.

CAVITY RESONATORS

Charts for Resonant Frequencies of Cavities.

R. N. Bracewell—*Inst. Radio Engrs. Proc.*, Aug., 1947; v. 35, pp. 830-841.

Six charts which may be used for designing cylindrical resonant cavities whose cross sections are circles, concentric circles, squares, or rectangles. A new method of representing multiple-resonance phenomena, to which the name "mode lattice" has been given.

CIRCUIT BREAKERS

Extinction of Arcs in Air-blast Circuit Breakers.

A. Allen and D. F. Amer—*I.E.E. Jour.*, Pt. II, Aug., 1947; v. 94, pp. 333-350, 362-371.

The development of the air turbulator and its application in commercial 66-kv and 132-kv circuit breakers. Tabulated data derived from an analysis of results of short-circuit tests.

ELECTRIC CURRENT RECTIFIERS, MERCURY ARC

Large Rectifier Station Practice.

Elec. Engng., Oct., 1947; v. 66, pp. 957-963.

Based on papers by four different authors connected with industrial concerns using mercury arc rectifier equipment.

ELECTRIC MOTORS, INDUCTION

Copperspun Squirrel-cage Rotor.

G. R. Anderson—*Elec. Engng.*, Oct., 1947; v. 66, pp. 980-982.

This article relates to a one-piece squirrel-cage rotor cast of copper by a centrifugal process. It is claimed to have numerous advantages over rotors of conventional design and construction.

FEEDWATER TREATMENT

Survey of German Feedwater Practice.

W. W. Cerna—*Power*, Sept., 1947; v. 91, pp. 600-604, 656c.

The War Utilities Subcommittee reports interesting developments that include corrosion prevention by ammonia in condensate, nitrogen in idle boilers.

FOUNDRY PRACTICE

Practical Aspects of Gray Iron Inoculation.

E. V. Somers and D. W. Gunther—*Iron Age*, Sept. 4, 1947; v. 160, pp. 72-75.

The authors explain, from the practical foundryman's viewpoint, what inoculation is, how and where it can be most profitably applied, its effect, and types of inoculants available.

GAS AND OIL ENGINES

Supercharged Dual Fuel Application.

Diesel Power, Sept., 1947; v. 25, pp. 35-38.

Describes a Worthington dual-fuel diesel engine in the municipal power plant at Lamar, Colorado.

GAS TURBINES

The Oerlikon Gas Turbine.

W. Karrer—*Bul. Oerlikon*, Dec., 1946; v. 26, pp. 1747-1748.

The construction of the Oerlikon gas turbine and the possibility of combining it with any steam or heating installation.

GEARING

The Closed Gear Train.

H. E. Merritt—*Engr.*, Sept. 26, 1947; v. 184, pp. 284-285.

Treats the theory and design of trains of simple gears in which each gear meshes with two neighboring ones.

GOVERNORS

Testing Governor Performance on Electric Power Systems With Improved Instruments.

J. E. Allen and W. B. Hess—*AIEE Tech. Paper 47-56*, 1946; 21 pp. (Temp.)

Instruments and methods used in testing governors for both steam and hydro units.

HEATING, RADIANT

Radiant Heating and Its Application to a Passenger Station.

Paul S. Park—*Ry. Age*, Sept. 6, 1947; v. 123, pp. 392-394.

A description of this system and its advantages, and a detailed explanation of the method and calculations involved in working out a practical problem in design.

INSULATORS

Toughened Glass Insulators.

Elec. Rev., Sept. 26, 1947; v. 141, pp. 461-466.

Production and testing processes. Constructed by an English concern.

JET PROPULSION

New Methods Developed for Evaluating Rocket Motors.

Aviation Week, Sept. 20, 1947; v. 47, pp. 20-21.

Production tests used for solid and liquid propellant charges, and instrumentation employed in these investigations.

LABORATORIES

Stratosphere Chamber.

Engr., Sept. 26, 1947; v. 184, pp. 296-298

Describes a laboratory for simulating high-altitude conditions at the plant of Vickers-Armstrongs, Ltd., England.

LIGHT-BEAM COMMUNICATION

Concentrated-arc Lamp in a Light Beam Communication System.

W. D. Buckingham and others—*Elec. Engng.*, Oct., 1947; v. 66, pp. 975-979.

The Western Union zirconium oxide lamp and its use in connection with a system of communication employing a modulated light beam.

LUBRICATIONS AND LUBRICANTS

Lubrication Requirements May Affect Designer's Decisions.

Elec. Mfg., Sept., 1947; v. 40, pp. 108-112, 166, 168, 170.

The importance of considering lubrication problems when designing electric equipment.

MACHINE TOOLS

More and Better Machines.

George W. Hoehler—*Auto. Ind.*, Sept. 1, 1947; v. 97, pp. 72-74, 170, etc.

High lights of modern advancements in mass production equipment and techniques which make possible lowered costs, improved quality, and increased rate of production.

MACHINE TOOLS

Special Cutters—Precise Fashioners of Complicated Shapes.

Jay DeEulis—*Steel*, Sept. 15, 1947; v. 121, pp. 88-91, 126, etc.

The production and applications of special types of cutters for machine tools.

MEASUREMENTS, PHYSICAL

Non-destructive Methods for Determining Metal Plate Thickness.

J. G. Kerley—*Corrosion*, Oct., 1947; v. 3, pp. 467-481.

Several different methods and instruments are described.

MEASURING INSTRUMENTS—SPEED

Useful Speed-time Analyser.

Engr., Oct. 3, 1947; v. 184, pp. 316-317.

A device for recording and integrating on a number of counters the total time during which a vehicle engine runs at various speeds.

ALS, PULVERIZED

rder Metallurgy.

ger W. Bolz—*Mach. Design*, Sept., 1947; 19, pp. 139-146.

One of a series of articles on production ocesses and their influence on design.

OTOTUBES

d-sulfide Photoconductive Cells for Sound Repro-tion.

J. Cashman—*Soc. Motion Pict. Engrs. ur.*, Oct., 1947; v. 49, pp. 342-348.

How these cells, in contrast with cesium-de phototubes used in present systems, nibit a much higher signal-to-noise out-t and a lower impedance.

STICS—MOLDING

cessing Polyvinylidene Chloride.

odern Plastics, Sept., 1947; v. 25, pp. 101.

On the molding and extrusion of Saran.

DIO ENGINEERING—CIRCUITS

rene-bass Potting Resin for High-frequency Circuits.

ec. Mfg., Sept., 1947; v. 40, pp. 120, 122.

Potting of subminiature components and assemblies—one of many possible com-ercial applications for a casting resin de-oped by National Bureau of Standards.

DIO ENGINEERING—FREQUENCY

Frequency Prediction Service for Southern Africa, h Special Reference to an Ionosphere Recorder bodying Certain New Techniques.

J. Hewitt and others—*S. Af. I.E.E. ans.*, July 1947; v. 38, pp. 180-197.

Outlines the work done, and an instru-ent used, in establishing a frequency pre-tion service for high-frequency radio mmunication.

REFRIGERATING ENGINEERING—COMPRESSORS

Compressor Capacity; Determination by Split Discharge System and Thin Plate Orifice.

A. D. Sullivan—*Refrig. Engng.*, Sept., 1947; v. 54, pp. 243-245, 276, 280.

An inexpensive means of determining the capacity or pumping ability of a refrigeration compressor.

RELAYS

Over-current Relays.

A. Salzmann—*Elec Rev.*, Oct. 3, 1947; v. 141, pp. 505-508.

Current-voltage relation for those of a directional type.

SMOKE PREVENTION AND ABATEMENT

How to Fire Oil or Gas Without Smoke.

L. N. Rowley and J. C. McCabe—*Power*, Sept., 1947; v. 91, pp. 592-596.

Basic data on the burning habits of hydrocarbons, gas and oil burners, and furnaces, plus practical pointers on operation and maintenance.

SPOT WELDING

Spot-welding French Autos.

Michael Marsh—*Weld. Engr.*, Sept., 1947; v. 32, pp. 33-37.

Ingenious spot-welding techniques which might be profitably studied here in the United States.

STEEL

Apparent Yield Strength of Plain Carbon Steel.

J. A. Pope—*Engng.*, Sept., 19, 1947; v. 164, pp. 284-288.

Presents test results. Abridged from a paper before the British Association.

STRAINS AND STRESSES

Photoelastic Stress Analysis.

Steel, Sept. 8, 1947; v. 121, pp. 84, 86.

The polariscope method as used in an English gear works.

TELEMETERS AND TELEMETRY

Telemetering Systems and Their Uses.

Perry Peterson and E. Wylie Head—*Elec. News & Engng.*, Sept. 15, 1947; v. 56, pp. 60-62.

A general description of the classes of telemetering and the work that can be done with telemetering equipment.

TIMING DEVICES

Application Circuits for Electronic Time-delay Relays.

E. H. Dinger—*Elec. Mfg.*, Sept., 1947; v. 40, pp. 98-101, 162, 164.

Describes four modes of operation of single-stage timers as well as various sequencing arrangements involving two or more electronic relays hooked up with magnetic relays.

TRACERS, RADIOACTIVE

Radioactive Tracers in Metallurgical Research.

E. S. Kopecki—*Iron Age*, Sept. 4, 1947; v. 160, pp. 60-64.

A new means of obtaining greater knowledge of rates and mechanisms of metallurgical reactions in molten and solid metals, described in an account of investigations under way at Carnegie Institute of Technology.

WATER TURBINES

Feathering-blade Water Turbine With Hydro-brake.

Engng., Oct. 24, 1947; v. 164, pp. 390-391.

Short description of a turbine developed by the English Electric Co.

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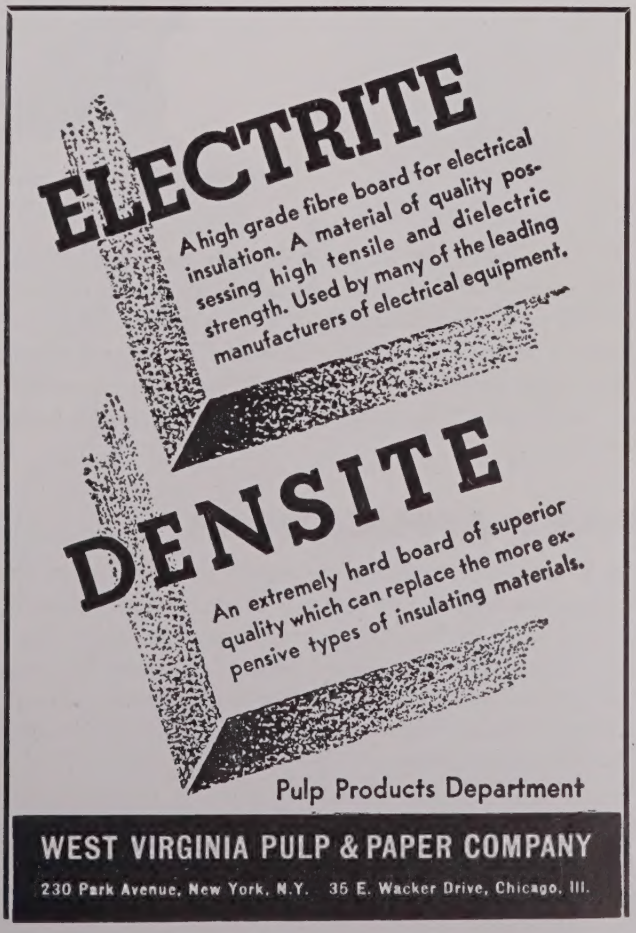
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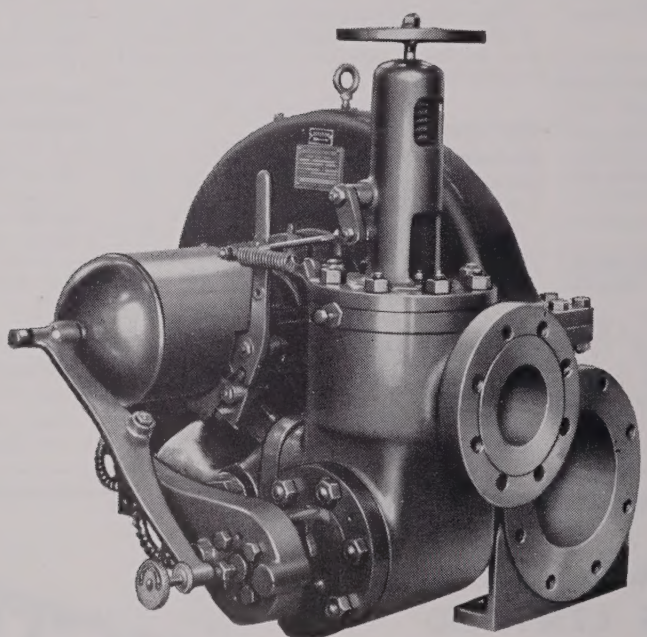

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